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Short Communication

Use of an optical surface scanner in assessment of outcome following rhinoplasty surgery

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Abstract

Objective: To demonstrate the use of an optical surface scanner, with associated software, in the assessment of rhinoplasty patients, and to discuss the possible clinical applications of this technology in the future.

Design: Case study analysis of pre- and post-operative scans of a patient undergoing septorhinoplasty at Whipps Cross University Hospital, London, UK.

Subject: A 21-year-old man undergoing septorhinoplasty underwent pre-operative optical surface scanning of his face. The scans were repeated at one week and one year post-operatively. Software developed at University College London was then used to analyse the scans.

Results: The scans clearly showed that the man's dorsal hump had been well reduced and the nose straightened, with a resulting 1600 mm^3 gain on the right side and a 1000 mm^3 loss on the left side of the nose. Tip projection had also been achieved.

Conclusion: This technique allowed objective quantification of facial features and analysis of change. It may well prove useful in the future in predicting change following surgical intervention.

Key words: Face; Nose; Imaging, Three-Dimensional; Surgical Procedures, Operative; Treatment Outcome

Introduction

The quantitative morphology of the face is of growing importance. In rhinoplasty surgery, standard, uniform colour photographs prior to and following surgery are the accepted means of storing an image of the nose and facial features. They allow pre-operative planning and provide a definitive record, enabling evaluation of the nose by both the surgeon and the patient. In addition, they form a valuable teaching tool and are a vital part of the medical and legal record.

However, one of the most significant limitations of such photographs in the planning of facial plastic procedures is the limitation of working with a two-dimensional likeness, while attempting to create a mental image of what is, in reality, a three-dimensional object. Such a limitation may significantly contribute to the dissatisfaction with the aesthetic outcome of surgery which is sometimes felt by both the patient and the surgeon.

The reliability of optical surface scanners in three-dimensional documentation of the face has already been reported.[1–4] Recent software development has extended the use of such systems; they can now be used to accurately analyse surgery outcomes, as well as to enable surgical simulation of the probable changes following operative intervention.[5]

We have been considering the application of this technique in the assessment of rhinoplasty patients, and we plan to use the technique to document cosmetic change following simple septoplasty surgery. In order to demonstrate this, we here present the pre- and post-operative optical scanning results from a patient undergoing corrective septorhinoplasty.

Technique

The technique records on-line the shape of a line of laser light projected onto the face (Figure 1). This line is then viewed obliquely by a closed circuit video camera via mirrors either side of the face. This viewing system minimises the loss of data due to shadowing of parts of the face by prominent features, principally the nose. Simple geometric analysis using the principles of triangulation allows this shape to be transformed into a set of three-dimensional co-ordinate points along the line illuminating the face. By rotating the subject under computer control, the whole of the face is scanned. Such a scan involves only a short exposure to a low intensity beam of laser light and is not hazardous. The reproducibility of this form of laser scanning has been previously demonstrated by Benn *et al.*[7]

Our patient was scanned pre-operatively before his corrective septorhinoplasty, and then one week post-operatively after splint removal (Figure 2). As it was unlikely that the patient would be scanned in exactly the

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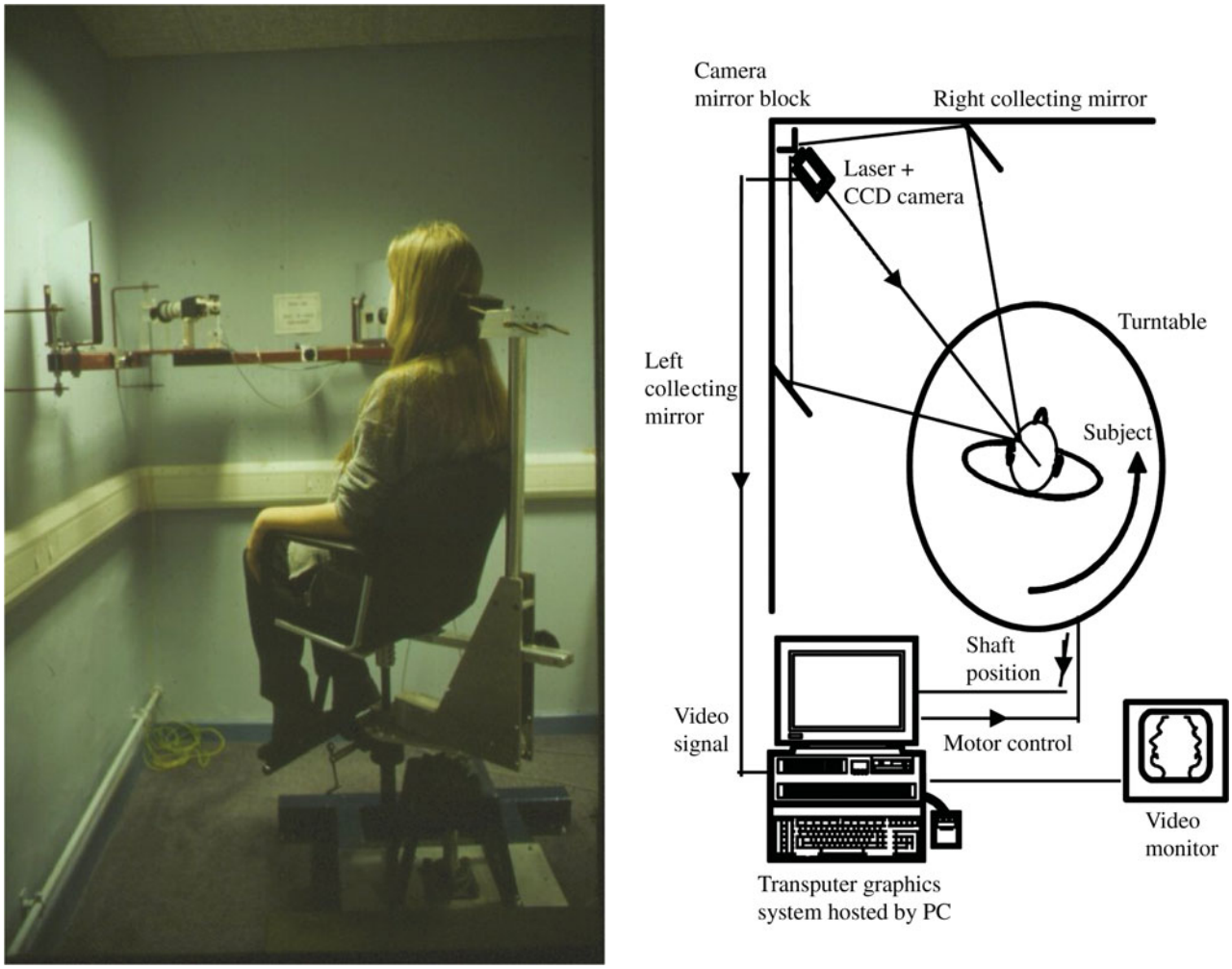

FIG. 1
Optical scanner. CCD = closed circuit digital; PC = personal computer. Reprinted with permission.[6]

same position on consecutive occasions, the scans were realigned (i.e. registered) prior to any comparisons being made. This was done by interactively 'painting' areas that were known to be unchanged between scans and by using physical markers positioned on the skin. An iterative closest point algorithm was then used to register the unchanged surfaces or markers; after registration, the difference between the pre- and post-operative scans (i.e. a three-dimensional 'difference map') was visualised and colour-coded. The volume differences over various regions of interest could then be computed (Figure 3). In addition, differing areas of interest could also be individually visualised. This can be seen in Figure 4, in which coding on a continuous colour scale was utilised; warm colours (green to red) were used to represent positive surface displacement and cold colours (blue to pink) to represent negative displacement. Turquoise areas represented surfaces that had not changed.

Finally, the process was repeated at one year; the results of this analysis are shown in Figure 5.

Discussion

The scans clearly show that the patient's dorsal hump has been well reduced and the nose straightened, with a resulting 1600 mm^3 gain on the right side and a 1000 mm^3 loss on the left side of the nose. Tip projection has also been achieved. Figure 4 shows the exact areas on the nose and face that have moved, and in which direction. Post-operative swelling of the cheeks is seen initially but, after one year, this swelling has settled especially over the dorsum of the nose (blue area); the nose itself remains straight (Figure 5).

In this report, we wish simply to present these images in order to demonstrate the measurement of the changes achieved by surgery. To date, we have not used the technique to predict outcome from different interventions prior to surgery. However, such manipulation is now possible, and this form of editing of the anatomical surface would allow both the patient and the surgeon to predict the probable results of different surgical manoeuvres. This, we think, would probably result in more realistic expectations of outcome for all involved. The technique also has other possible uses. We are presently considering its application in the assessment of the degree of cosmetic change that follows septal surgery in adults. It is known that such changes may occur; however, good, prospective studies with subjective and objective data are rare,[8–10] and different rates of change have been reported ranging from 0 to 21 per cent.[11–13] To

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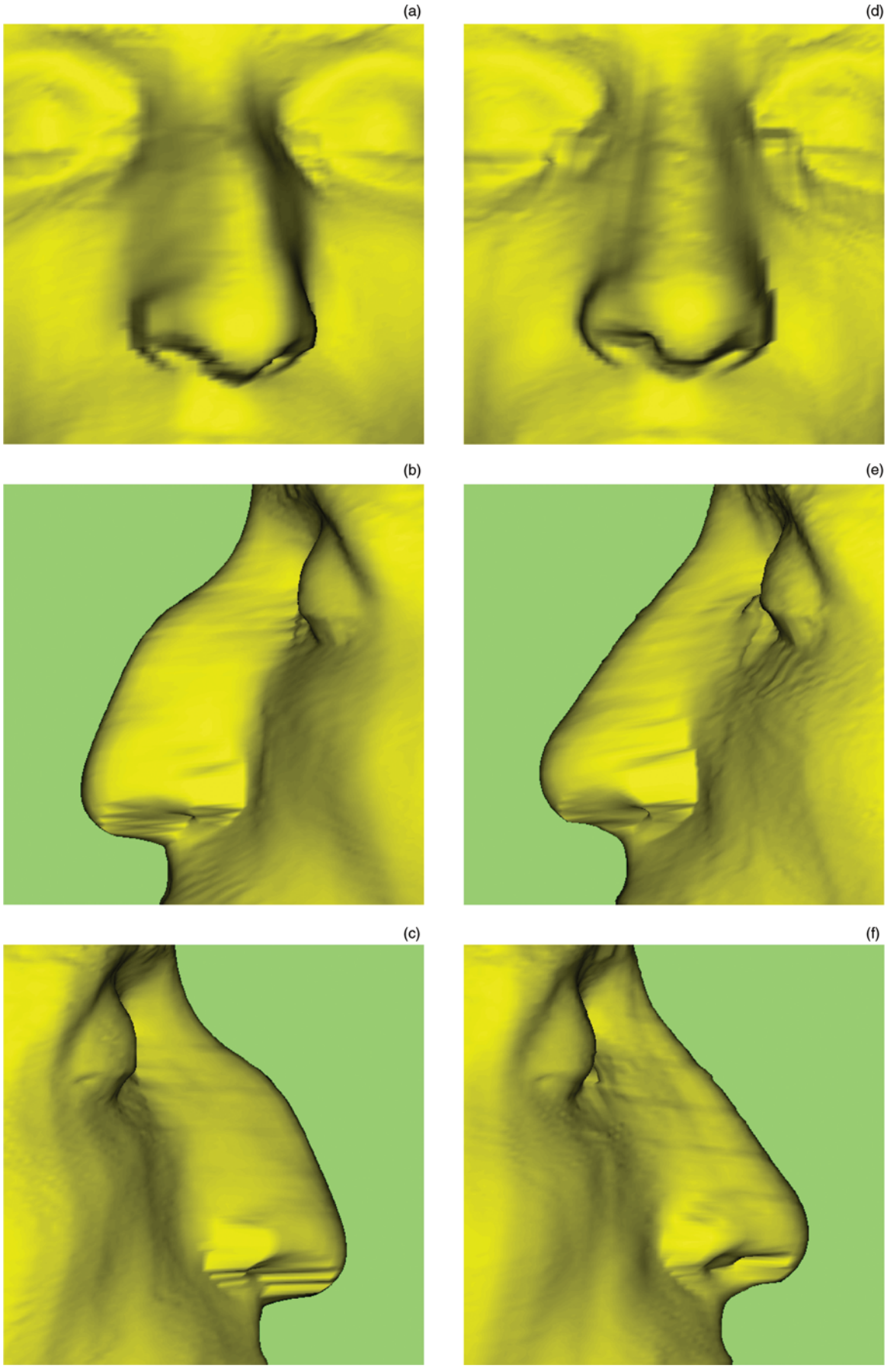

FIG. 2
Laser optical scans: pre-operative ((a) to (c)) and one week after corrective septorhinoplasty ((d) to (f)).

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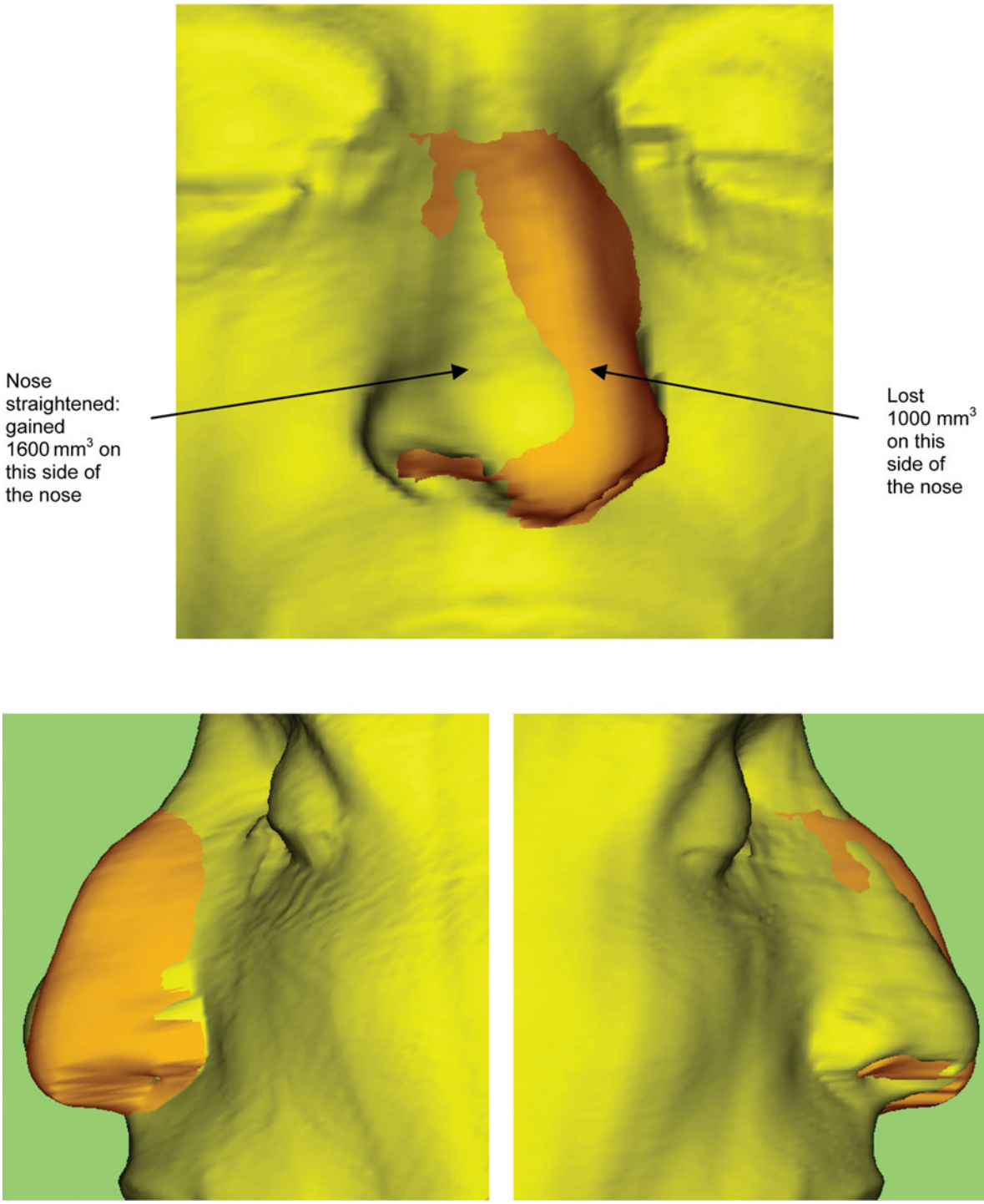

FIG. 3
The two initial scans superimposed: orange = pre-operative; yellow = post-operative.

date, such studies have all relied on standardised photographs and have been subjective, relying as they have on the impressions of differing numbers of observers. As we have shown in this report, the use of an optical surface scanner would allow wholly objective quantification of any such changes, and might well allow such changes to be predicted in certain situations; this would also allow better data to be available for informed consent.

Conclusion

In conclusion, we present the results of using an optical surface scanner in the evaluation of nasal architecture

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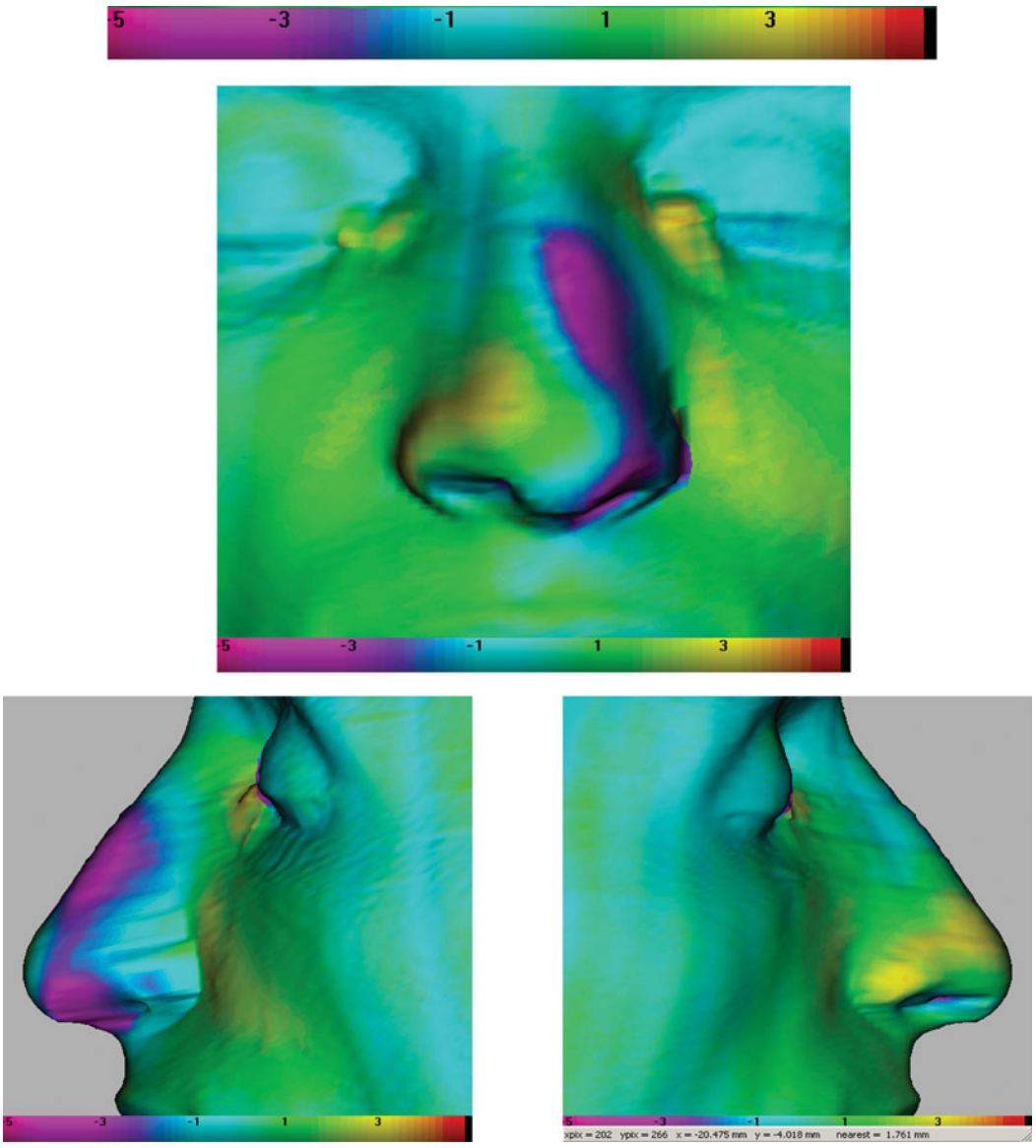

FIG. 4

Post-operative scan analysis: warm colours (green to red) represent positive surface displacement (in millimetres); cold colours (blue to pink) represent negative displacement. Turquoise areas represent surfaces that have not changed.

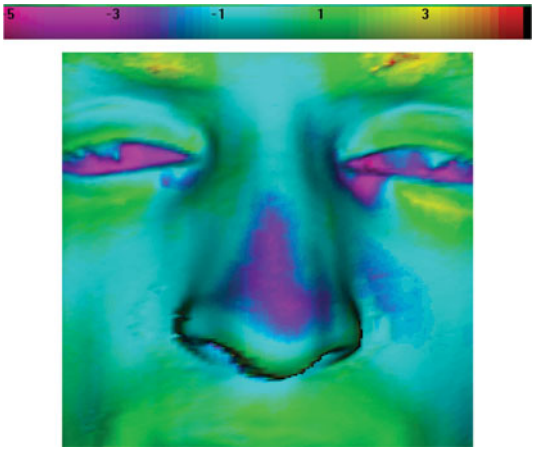

FIG. 5

Repeat scan analysis, one year post-operative.

before and after rhinoplasty surgery. This technique allows objective quantification of facial features, and this may well prove useful in the future in predicting change following surgical intervention.

References

1 Kusnoto B, Evans CA. Reliability of a 3D surface laser scanner for orthodontic applications. *Am J Orthod Dentofacial Orthop* 2002;**122**:342–8
2 Soncul M, Bamber MA. The optical surface scan as an alternative to the cephalograph for soft tissue analysis for orthognathic surgery. *Int J Adult Orthodon Orthognath Surg* 1999;**14**:277–83
3 Bush K, Antonyshyn O. Three-dimensional facial anthropometry using a laser surface scanner: validation of the technique. *Plast Reconstr Surg* 1996;**98**:226–35
4 Aung SC, Ngim RC, Lee ST. Evaluation of laser scanner as a surface measuring tool and its accuracy compared with

https://doi.org/10.1017/S0022215108002302 Published online by Cambridge University Press

direct facial anthropometric measurements. *Br J Plast Surg* 1995;**48**:551–8
5 Moss JP, Ismail SF, Hennessy RJ. Three-dimensional assessment of treatment outcomes on the face. *Orthod Craniofac Res* 2003;**6** (suppl 1):126–31; 179–82
6 Linney AD, Campos J, Richards R. Non-contact anthropometry using projected laser. *Optics and Lasers in Engineering* 1997;**28**:137–55
7 Benn P, Ruff C, Cartledge J, Sauret V, Copas A, Linney A *et al*. Overcoming subjectivity in assessing facial lipoatrophy: is there a role for three-dimensional laser scans? *HIV Med* 2003;**4**:325–31
8 Schwab JA, Pirsig W. Complications of septal surgery. *Facial Plast Surg* 1997;**13**:3–14
9 Marshall AH, Johnston MN, Jones MD. Principles of septal correction. *J Laryngol Otol* 2004;**118**:129–34
10 Jones NS. Principles of correcting the septum in septorhinoplasty: Two-point fixation. *J Laryngol Otol* 1999;**113**: 405–12
11 Vuyk HD, Langenhuijsen KJ. Aesthetic sequelae of septoplasty. *Clin Otol* 1997;**22**:226–32
12 Muhammad IA, Nabil-ur Rahman. Complications of surgery for deviated nasal septum. *J Coll Physicians Surg Pak* 2003;**13**:565–8
13 Low WK, Willatt DJ. Submucous resection for deviated nasal septum: a critical appraisal. *Singapore Med J* 1992; **33**:617–19

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