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Uses and abuses of digital imaging in plastic surgery

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Abstract *Background:* Surgeons extensively rely on photographic communication for documenting surgical results, teaching and research, and obtaining informed consent from patients. With the advent of digital photography and widespread availability of sophisticated image manipulation software, the potential for committing digital fraud cannot be discounted.
Methods: Ten 'before' and 'after' plastic surgical photographs were selected, and a number of them were digitally enhanced using a standard desktop software by a non-expert in digital photography. A panel of 10 consultant plastic surgeons was asked to judge which, if any of the images had been digitally manipulated.
Results: Expert assessment had a sensitivity of only 12% in identifying digitally manipulated images. Furthermore, there was poor interobserver agreement with an Intraclass Correlation Coefficient of 0.39.
Conclusion: Digital fraud is easy to commit and difficult to detect. Furthermore, a number of inadvertent and simple image manipulation functions can also amount to misrepresentation. There may be scope for cooperation within editorial circles to set standards for the submission of digital photographs. Surgeons need also to be aware of the potential for misrepresentation of information through digital image manipulation and exercise caution in the communication of digital photographic information.

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Introduction

Plastic surgery is a visual speciality and relies implicitly on photographs for documentation of surgical results, for teaching and research, and as an aid to obtaining the informed consent of patients. The past decade has seen a revolution in digital technology, with high-resolution digital cameras and sophisticated image manipulation software now readily available at reasonable expense.

These advances provide exciting new opportunities for better documentation and communication of surgical results,[1] but also raise the unwelcome spectre of fraud. Digital image manipulation is not fraudulent per se, and indeed disciplines like diagnostic radiology are much aided by it,[2,3] but in plastic surgery, manipulating an image in such a way that it gives a more favourable impression of scarring or the aesthetic form is at best misleading.

These considerations are particularly pertinent today as many academic journals now accept digital images for publication purposes, and the visual medium, especially the world wide web, is being increasingly used to directly communicate with the public. We investigated the feasibility and consequences of performing 'desktop plastic surgery' on standard plastic surgical photographs using a personal computer and a widely-used image manipulation software.

Methods

With the informed written consent of the participants, 10 before and after plastic surgical photos, including breast reduction and reconstruction, rhinoplasty and scar revision were obtained. The images were digitised using a high-resolution scanner, with the same image acquisition settings being used for all photographs. Five of these images were then manipulated using a readily-available image manipulation software (Paint Shop™ Pro® 6, Jasc® Software Inc., USA). Examples of manipulations performed included reducing the prominence of postoperative scarring or 'performing' complete 'desktop plastic surgery' on preoperative photographs (Fig. 1).

All of these digitised images, including the non-manipulated ones were then reprinted on $5'' \times 7''$ photographic paper by medical photography department and were thus 'converted back' to 'hard copy' photographs.

A panel of 10 consultant plastic surgeons independently reviewed these images. The surgeons were told that none, some or all of these images may have been digitally manipulated. To further safeguard surgeon objectivity, they were told before viewing these photographs that this series of 10 was one of a number of series of photographs they would be asked to review, within which manipulated images were randomly inserted, and they should therefore make no assumptions about the presence or absence of manipulated image in the particular series they were reviewing. The surgeons were simply asked to identify the manipulated photographs and state in which way they thought the images had been altered.

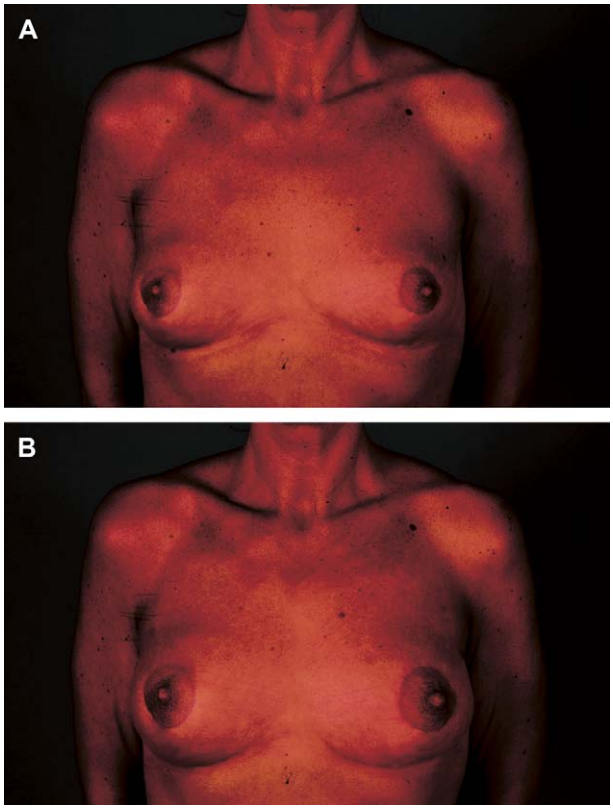

Figure 1 Breast augmentation surgery. The postoperative photograph has been manipulated to reduce scar prominence.

Sensitivity of surgeon assessment as a method of identifying fraudulent photographs was calculated and the concordance between the assessments of different surgeons in identifying manipulated photos was obtained using Intraclass Correlation Coefficient.

Results

Fig. 2 shows an example of a manipulated photograph used in this study. There were five manipulated and five un-manipulated photographs in the series. Consultant plastic surgeons correctly classified all un-manipulated images as such, but were

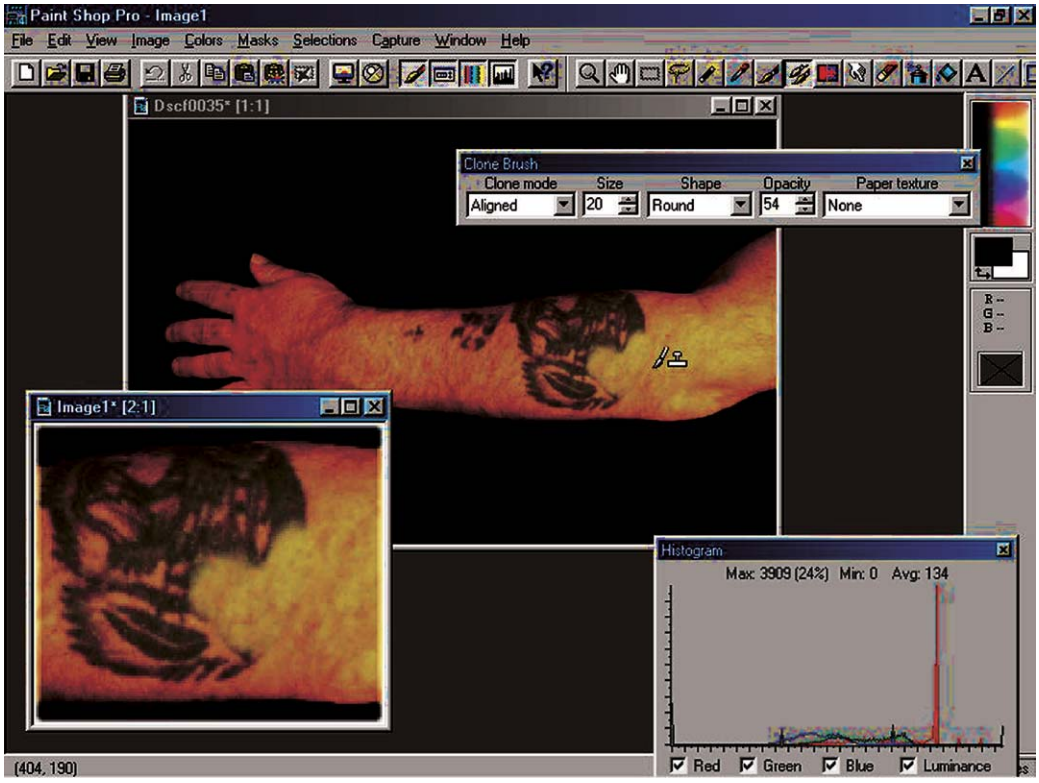

Figure 2 An example of Paint Shop Pro being used to alter a plastic surgical image.

unable to correctly identify manipulated photographs, classifying the majority of them as unmanipulated. Expert assessment had an overall sensitivity of 56%, and a sensitivity of 12% in correctly identifying a manipulated photograph. As there were no ''false positive'' cases (i.e. unmanipulated images being identified as manipulated), we were unable to calculate specificity. An Intraclass Correlation Coefficient of 0.39 for correct identification of manipulated images was obtained, indicating a poor degree of concordance between different surgeons.

Discussion

Digital fraud is easy to commit and difficult to detect. This has important consequences on plastic surgery, which relies more than most other specialities on photography for the documentation of surgical results.[4] Photographic misrepresentation is of course as old as photography itself, having been used, inter alia, to prove the existence of the paranormal in the form of psychic photography, and for political propaganda. What has changed in the recent past is that with the advent of digital technology, the ability to perform quite sophisticated image manipulation has moved from the dark room and the domain of a few highly skilled technicians to any personal computer and any person with a reasonable knowledge of information technology.[5,6] The necessary software is readily available and the knowledge to perform image manipulation can be easily acquired from online tutorials, by purchasing books on digital photography, as well as an increasing number of tutorials in the medical literature.[3–12]

Importantly, photographic misrepresentation is not confined to post-acquisition image manipulation. For example, changing the camera's flash settings or the ambient light can radically change the characteristics of the images. The resulting effect is that two consecutive photographs, taken seconds apart, could be convincingly presented as the before and after results of laser facial rejuvenation.[7] Furthermore, different digital cameras have different characteristics and changing camera could quite easily skew photographic representation.[13] It is important also to note that photographic misrepresentation is not a problem confined to plastic surgery. For example, changing the camera's flash settings or altering colour characteristics of the image can significantly alter the photographic appearance of a segment of bowel when a photograph is taken to document appearance in the context of a strangulated hernia.

However, a reactionary move back to film photography is neither useful, nor would do much to combat fraud, as it is now quite easily possible to print 'hard copies' of digital photographs, as was the case in our study. What then can be done to counter digital fraud? The first step is to raise awareness of it within surgical and editorial circles. The best time to recognise a manipulated image is when it is in high-resolution digital format (i.e. when it has been submitted for publication). It is rather more difficult to recognise a manipulated image from the single-column printed version. The British Journal of Plastic Surgery has set out detailed requirements for submission of surgical photographs, requiring them not to have been ''altered or retouched in any way''. Furthermore, it requires that ''before and after photographs of patients should be standardized in terms of size, position and lighting''. Plastic and Reconstructive Surgery requires that ''no photographs, digital or otherwise, should be substantially modified''. Similar requirements could not however, be found in the ''Guide to Authors'' sections of most otolaryngology or maxillofacial journals (where plastic surgical research is also considered for publication) nor in instructions to authors submitting research to many of the general surgical journals. There may be scope for editors of journals to define and agree upon acceptable levels of image adjustment, and require a declaration that submitted images have not been digitally manipulated.

It is important to realise also, that not all image manipulations are misrepresentations. It may be very legitimately necessary to 'crop' a picture, remove patient labels, cover eyes or add arrows and annotation to an image. It may similarly be considered a legitimate use of digital photography to remove a distracting background from a surgical image to enhance clarity. The difficulties arise with the use of 'airbrush' and 'colouring' tools, and with global changes to image contrast, light settings or colour and saturations.

In our opinion, manipulation of localised areas of the image, for instance to reduce scar prominence, is clearly unacceptable, while changes to image size and cropping are acceptable as long as important information is not 'cropped out'. We also consider making global changes to image characteristics, such as changing contrast and colour settings unacceptable, given that such changes can have differential effects on different areas of the image. For example, in a dark-skinned patient, careful changes to colour saturation channels can lead to changes in the colour contrast between the scar and adjacent areas, with the net effect of reducing scar prominence.

This study aims to raise awareness within the surgical research community of the fine line between improving image clarity and inadvertent misrepresentation of surgical results. Standardization of plastic surgical views,[4,7,11,13,14] using the same camera to obtain before and after photographs[13] and ensuring that all images are obtained under similar lighting conditions[7] and to the same scale[1] would go a long way toward obviating the need to perform post-acquisition image manipulation. Such manipulations, if at all necessary, should then be restricted to removing patient labels, adding annotation, making a photograph unrecognizable if necessary, and cropping unnecessary background.

In order to maintain the trust of our patients and the public, plastic surgeons like all doctors must adhere to high standards of probity. The use of digital images in plastic surgery has considerable advantages and the ease with which it can be abused must not be allowed to undermine this valuable method of communication.

References

1. Russell P, Nduka C. Digital photography for rhinoplasty. *Plast Reconstr Surg* 2003;**111**:1366.
2. Corl FM, Kuszyk BS, Garland MR, Fishman EK. 3D volume rendering as an anatomical reference for medical illustration. *J Biocommun* 1999;**26**:2–7.
3. Corl FM, Gerland MR, Lawler LP, Fishman EK. A five-step approach to digital image manipulation for the radiologist. *Radiographics* 2002;**22**:981–92.
4. Rhodes ND, Southern SJ. Digital operation notes: a useful addition to the written record. *Ann Plast Surg* 2002;**48**:571–3.
5. Camarena LC, Guerrero MT. Digitization of photographic slides: simple, effective, fast, and inexpensive method. *Ann Plast Surg* 2002;**48**:323–7.
6. Benz C. Digital photography: exposures, editing images, and presentation. *Int J Comput Dent* 2003;**6**:249–81.
7. Miamtu J. Image is everything: pearls and pitfalls of digital photography and PowerPoint presentations for the cosmetic surgeon. *Dermatol Surg* 2004;**30**:81–91.
8. Niamtu J. The power of PowerPoint. *Plast Reconstr Surg* 2001;**108**:466–84.
9. Niamtu J. Techno pearls for digital image management. *Dermatol Surg* 2002;**28**:946–50.
10. Sandler J, Murray A. Manipulation of digital photographs. *J Orthod* 2002;**29**:189–94.
11. Papel ID, Jiannetto DF. Advances in computer imaging/applications in facial plastic surgery. *Facial Plast Surg* 1999; **15**:119–25.
12. Furness PN. The use of digital images in pathology. *J Pathol* 1997;**183**:253–63.
13. Galdino GM, Vogel JE, Vander Kolk CA. Standardizing digital photography: it's not all in the eye of the beholder. *Plast Reconstr Surg* 2001;**108**:1334–44.
14. Becker DG, Tardy ME. Standardized photography in facial plastic surgery: pearls and pitfalls. *Facial Plast Surg* 1999; **15**:93–9.