



Where to draw the line: the error in marking surgical excision margins defined

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Summary We studied the accuracy of marking surgical margins for excision surrounding skin lesions, to assess if the percentage error would differ for varying increments in margin measurements. In designing an experiment to test this hypothesis, surgeons of differing experience ($n = 19$) marked excision margins of 2, 5 and 10 mm around a standard circular lesion drawn on paper. Use of surgical markers, rulers and loupe magnification were all permitted, with five attempts for each margin. The percentage error found was 35, 14 and 4% for the 2, 5 and 10 mm margins, respectively (regardless of the grade of surgeon).

Repetition of the experiment on volunteer skin demonstrated a percentage error of 45, 16 and 8% for 2, 5 and 10 mm margins (significantly greater than the corresponding errors on paper, $p < 0.001$ in all cases).

These findings indicate that for these surgically marked margins, the term 'accurate excision margins' may be inaccurate to a significant degree. This study has defined the errors inherent in the marking of surgical margins, and these should be taken into account when assessing studies that report margins around tumours. Specifically, comparisons between surgical and histological margins would aid assessment of reports detailing surgical margins drawn around skin tumours.

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A previous study defined the relationship between the surgical margins drawn around basal cell carcinomas and the subsequent histological margins measured.¹ Whilst it was recognised that after tumour excision there would be primary tissue contraction, and after formalin fixation, secondary tissue contraction^{2,3} the study did not define the initial accuracy or error in the marking of the

surgical excision margin. Thus, in the present study, we sought to explore the issue of the error inherent in drawing margins around tumours.

Textbooks and papers advise a variety of surgical margins to be marked around skin tumours, with these margins often said to influence prognosis.⁴⁻⁹

However, such advice presumes margin measurement accuracy and reproducibility by individual clinicians and between operators. If these are flawed assumptions, a small margin measurement would *per se* result in a significant degree of inter and intraobserver error, increasing with diminishing margin size.

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Table 1 Study on paper. Proportionate errors for marking margins around a standard lesion

| Desired margin (mm) | Average drawn margin (mm) $n = 95$ | Standard deviation | SEM | % Error | % Over-estimations |
|---------------------|------------------------------------|--------------------|-------|---------|--------------------|
| 2 | 2.7 | 0.190 | 0.023 | 35 | 93 |
| 5 | 5.7 | 0.139 | 0.020 | 14 | 90 |
| 10 | 10.4 | 0.156 | 0.020 | 4 | 92 |

We therefore sought to define and quantify such putative errors that may exist within a range of measured margins both *in vitro* and *in vivo*.

Materials and methods

Surgeons of varying experience ($n = 19$) were asked to draw margins of 2, 5 and 10 mm around a standard circular illustration (5 mm diameter) on white paper, using a standard surgical marker pen (fine nib, Viomedex). Rulers and loupe magnification were permitted. The technique was then repeated on the dorsal hand skin of a volunteer (the first author) with the metacarpo-phalangeal joints flexed and the wrist in a neutral position. The thickness of the pen mark left on the paper and skin was noted.

Each surgeon made five attempts for each margin. Quadrants were then drawn for each attempt (Fig. 1) and margins measured at four points with callipers graduated to 0.05 mm to produce a mean calculated for each attempt. Measurements were taken to the point where the surgeon indicated that an incision would be placed (i.e. on the inside or outside of the line). It is accepted that callipers graduated to 0.05 mm may produce an error of 1% when measuring a 5-mm margin.

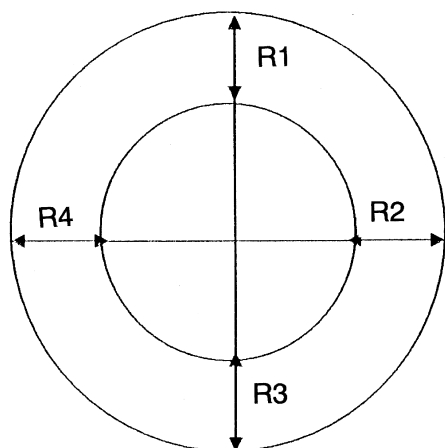


Fig. 1 R_{AV} is the average of four quadrant measurements $R_{AV} = R1 + R2 + R3 + R4/4$.

One way ANOVA was used to assess difference between operators, and Student's *t*-test to evaluate the difference between margins of different sizes.

Results

There were no significant differences between the errors produced by different surgeons, and therefore for subsequent analysis all surgeons were treated as a homogeneous group.

The margin measurements obtained are detailed in Table 1 for the paper study and in Table 2 for the skin. The percentage errors on paper were 35, 14 and 4% for 2, 5 and 10 mm margins, respectively.

The equivalent figures for the measurements on skin were 45, 16 and 8%, which were significantly greater than the corresponding errors on paper ($p < 0.001$ in all cases).

Figs. 2 and 3 show the scatter of surgical margins for both paper and skin, which again demonstrate a greater range for the 2-mm margin for both paper and skin.

The pen used (fine nib, Viomedex) produced a significantly thicker mark ($p = 0.0034$) on skin (1.0 mm) compared to paper (0.6 mm).

Discussion

Recently published guidelines for the management of the three common skin malignancies¹⁰⁻¹² repeat advice from textbooks and previous publications⁴⁻⁹ that certain measured margins (often but a few mm) of apparently normal skin be excised around skin tumours. It is presumed that excising such margins confers a prognostic benefit. Such advice also presumes that it is easy and reproducible to mark accurate surgical margins.

Basic physical theory suggests that measurement of any small quantity may be inherently inaccurate and difficult to reproduce. This has been the finding of this study, with the inaccuracy persisting despite the use of loupe magnification and rulers.

Errors were significantly greater on skin com-

Table 2 Study on skin. Proportionate errors for marking margins around a standard lesion

| Desired margin (mm) | Average drawn margins (mm) <i>n</i> = 75 | Standard deviation | SEM | % Error | % Over-estimations |
|---------------------|--|--------------------|-------|---------|--------------------|
| 2 | 2.9 | 0.241 | 0.041 | 45 | 97 |
| 5 | 5.8 | 0.183 | 0.037 | 16 | 98 |
| 10 | 10.8 | 0.175 | 0.434 | 8 | 93 |

pared with paper for all margins ($p < 0.001$), reflecting the thicker pen mark and the difficulties of working with skin contours rather than a flat immobile surface. Our finding that the fine nib Viomedex pen drew a line on skin 1.0 mm wide compares with a 0.8 mm width reported for the same pen on skin by Stromberg.¹³

If the accuracy of marking with commercially available felt pens cannot be relied upon, it is possible that greater precision could be provided by fine tipped skewers¹⁴ and other appropriate marking material.¹⁵⁻¹⁷

Interestingly, the majority of attempts for each margin drawn were an over-estimation of distance, regardless of the level of surgical experience.

These findings are of particular relevance to the advice from several authors that the excision margin around some sub-types of basal cell carcinoma be 2 mm.^{4,6} It is for this margin size we have

shown an error of 45% for skin specifically. In the light of our findings, adherence to recommended excision margins should be approached with some circumspection. In particular, regardless of the documented measured surgical margin, comparison with the subsequent histological margin^{18,19} should always be made as a check to the relative accuracy of the surgical margin assessment. Our work indicates that measurements referred to in previous publications have suggested a false precision which is not attainable.

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Deviation of marked margins from ideal (on paper)

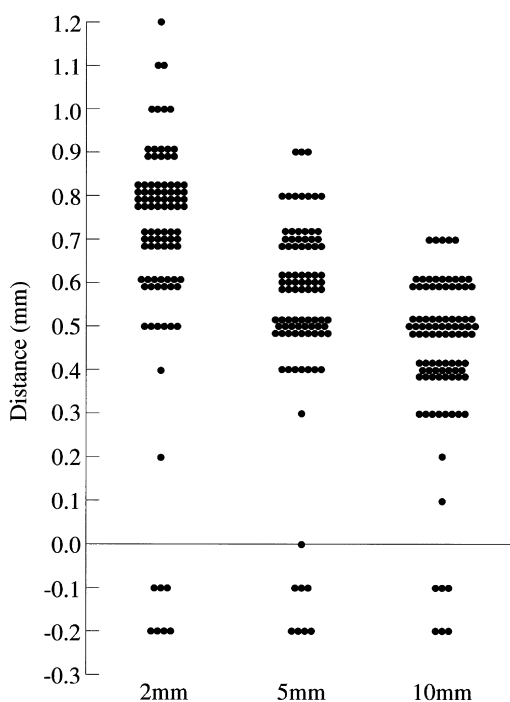


Fig. 2 Deviation of marked margins from ideal (paper).

Deviation of marked margins from ideal (on skin)

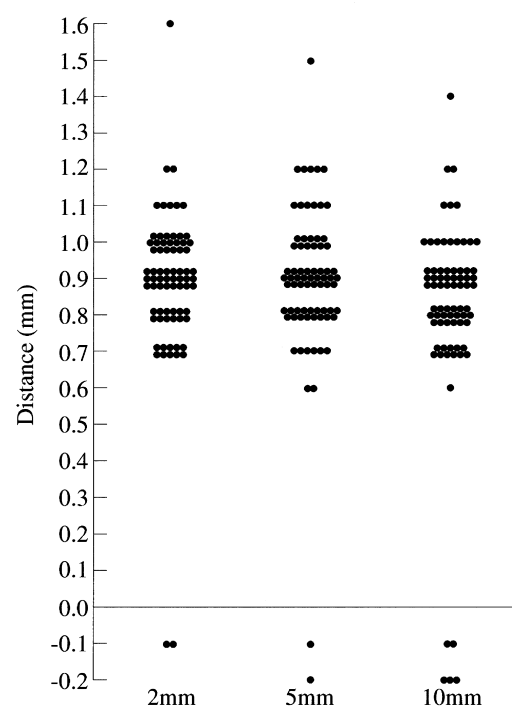


Fig. 3 Deviation of marked margins from ideal (skin).

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