# Tissue Shrinkage in Melanoma Excision Margins

A companion note to the Clinical and Histological Margins in Melanoma Surgery and the Evidence Supplement, focused specifically on what the published evidence shows about the gap between the clinical (surgical) margin and the histological (pathology-reported) margin, and why it exists.

Associated resources on this topic are available at:
https://www.skincancersymposiums.com/resources

## Why the Numbers Differ

When a margin is marked and cut in vivo, the tissue removed does not arrive on the pathologist's slide at the same size. Two things happen. First, the specimen contracts almost immediately after excision as the tension holding the skin taut is released — this is intrinsic elastic recoil of the dermis, not a chemical effect. Second, a smaller further contraction occurs during formalin fixation and histological processing. Kerns et al. (2008) directly tested which of these dominates by measuring specimens in vivo, again a few minutes after excision (before fixation), and again after fixation, and found that the great majority of the total shrinkage had already occurred before the tissue reached formalin — concluding that shrinkage is mainly a property of the living tissue's own elasticity, not an artefact of fixation (1).

## What the Measured Studies Show

The reported size of the effect varies across studies, partly because they measure different things: some measure the width of the radial margin specifically (the figure most relevant to melanoma surgery), others measure the overall length of the specimen, and others measure area. The most directly relevant, purpose-built studies are summarised below.

1. Kerns et al. (2008) prospectively measured 97 skin specimens in vivo, again 1 minute after excision (ex vivo), and again after 24-48 hours of formalin fixation. Mean shrinkage

measured immediately after excision (i.e. before any fixation effect) was 20.7% in length and 11.8% in width — width being the dimension that corresponds to a radial margin. The range was wide (0–41.2% for length; –18.8% to 37.5% for width, the negative figure reflecting a small number of specimens that appeared to expand slightly). Shrinkage fell by approximately 0.3% for every year of increasing patient age, trunk specimens shrank around 5% more than head and neck specimens, and shrinkage was reduced as the degree of solar elastosis increased (1).

2. Friedman et al. (2019, Annals of Surgical Oncology, first published online 2018) measured 252 melanoma wide local excision specimens and found a mean shrinkage of 14% between the surgeon's measured in vivo margin and the fixed histological specimen, consistent across patients and excision sites. Because the correlation between the surgical margin and the eventual histological margin was still weak ($R^2 = 0.55$), the authors proposed a 15% correction factor as a practical estimate rather than a precise prediction for an individual case (2).
3. Licata et al. (2022, JAAD International), in their analysis of 1407 patients with melanoma in situ, cited their own group's prior finding of a 14% shrinkage rate as the basis for choosing a 4 mm pathological margin as the threshold to study — reasoning that a 4 mm histological margin approximates the 5 mm clinical margin recommended by most guidelines once shrinkage is accounted for. They separately noted that a wider surgical margin (around 6.5–7.5 mm) may be needed in practice to reliably achieve a 3–4 mm histological margin, since the relationship between the two is not exact (3).
4. de Waal et al. (2021, ANZ Journal of Surgery) conducted a further prospective study of skin tumour specimen shrinkage with excision and formalin fixation, examining how much shrinkage occurs and why (4).
5. Alves Wainstein et al. (2021, European Journal of Surgical Oncology) measured 145 melanoma margin-enlargement specimens in a Brazilian cohort and found a median length retraction of around 17% between in vivo and ex vivo measurement (with a larger reduction, 38–44%, when measured by area rather than length). On average, the margin the pathologist ultimately measured represented about 80% of the margin the surgeon had cut (5).

## Summary of Reported Shrinkage Figures

| Study | What was measured | Reported shrinkage | Note |
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| **Kerns et al. 2008 (1)** | Radial width, pre-fixation | 11.8% mean (range –18.8% to 37.5%) | Width is the dimension relevant to a radial margin |
| **Kerns et al. 2008 (1)** | Length, pre-fixation | 20.7% mean (range 0–41.2%) | Length shrinks more than width |
| **Friedman et al. 2019 (2)** | Overall specimen width, fixed | 14% mean | 252 melanoma WLE specimens; poor predictor of individual case ($R^2 = 0.55$) |

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| **Alves Wainstein et al. 2021 (5)** | Length, in vivo to ex vivo | ~17% median | 145 melanoma margin-enlargement specimens |
| **Alves Wainstein et al. 2021 (5)** | Area | 38–44% | Area shrinkage is much larger than linear shrinkage |

## What Drives the Variation

- Patient age — younger, more elastic skin shrinks more. Kerns et al. found shrinkage fell by roughly 0.3% per year of increasing age (1).
- Anatomical site — trunk skin, under higher baseline tension, shrinks more than head and neck skin (around 5% more per Kerns et al.) (1).
- Solar elastosis — chronically sun-damaged skin, common at sites where lentigo maligna arises, has reduced elastic recoil and so shrinks less than protected skin. This is a difference of degree, not an absence of shrinkage altogether — the literature does not support treating sun-damaged skin as shrinkage-free (1).
- What is measured — area shrinks proportionally much more than a single linear dimension, and length shrinks more than width.
- In vivo vs ex vivo vs post-fixation — studies that measure only the final fixed specimen against the original surgical margin (as most clinically relevant studies do) capture the combined effect of both retraction and fixation; studies that isolate the pre-fixation retraction step, like Kerns et al., show that this step accounts for most of the total change (1).

## Why the Studies Don't Fully Agree

Reported shrinkage figures cluster in a wide range — roughly 12% to 20% for width or overall specimen size in the more directly comparable prospective studies, and higher still when length or area is measured instead. This spread reflects genuine differences between cohorts (age mix, anatomical site mix), differences in exactly what was measured, and the inherent biological variability between individual patients and lesions that Friedman et al. captured in their weak $R^2$ of 0.55 — a formal way of saying that even a well-established average shrinkage figure predicts any single patient's result poorly.

## How This Bears on the Floor-Value Calculation in the Brief Document

The discussion document Clinical and Histological Margins in Melanoma Surgery uses a deliberately conservative 40% shrinkage assumption to calculate a "floor" value below which a histological margin should not usually fall, given a specified minimum clinical margin — explicitly flagged there as a worst-case figure rather than a typical one. The evidence reviewed here supports that framing: the best-controlled, purpose-built studies measuring width specifically

(Kerns et al., 11.8% mean; Friedman et al., 14% mean) report shrinkage well below 40%, and even the upper end of Kerns et al.'s reported width range (37.5%) sits just under it. The 40% figure therefore remains a genuinely cautious lower bound for the floor calculation, not a realistic expectation of what most excisions will show — actual shrinkage will typically be less than this, often substantially so.

## References


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5. Alves Wainstein, A. J., Flores Ferrão, E. O., Virgílio Alves, A. C., Borges Murta, M. C., & Drummond-Lage, A. P. (2021). Assessment of retraction in surgical specimens in melanoma patients submitted to oncological amplification of margins. European Journal of Surgical Oncology. https://pubmed.ncbi.nlm.nih.gov/33340807/