Color difference

The difference or distance between two colors is a metric of interest in color science. It allows a quantified examination of a notion that formerly could only be described with adjectives. Quantification of these properties is of great importance to those whose work is color-critical. Common definitions make use of the Euclidean distance in a device-independent color space.

The aim was to evaluate which color difference formula was the most optimal to distinguish between malignant brain tumors from the background healthy tissue using 5-ALA fluorescence.

37 patients with a primary or secondary malignant brain tumour ingested 5-ALA before the surgery. A 400 nm light was used to excite the fluorescence. Surgical videos were recorded for all the patients and a total of 183 samples were obtained from the fluorescent areas and their respective backgrounds. Three colour differences formulas-contrast ratio (CR), CIELab (ΔE*) and CIEDE2000-were applied to the videos and compared using hot-cold maps. Baseline demographics, the tumour's location, the tumour's side, and tumour's World Health Organisation (WHO) grade was also analysed for correlations relating to the fluorescence. Chi-square and the Student's t-test were used for univariate relations. The three channels of the CIELAB colour space (L*, a* and b*) were analysed together and separately (since L* of fluorescent areas was significantly higher than the background).

ΔE* resulted in good discrimination of a* and b*, and moderate but acceptable discrimination of L*. CIEDE2000 distinguished differences in a* and b*, although, not in L*. The CR distinguished only L*, whereas the probability of discriminating a* and b* channels failed. Neither age, sex, tumour location, tumour size or the WHO grade influenced the a*, b* and L* colour values ($p > 0.05$). Colour differences measured by ΔE* and CIEDE2000 correlated together ($r=0.99$, $p<0.01$), whereas CR correlated only with ΔE ($r=0.21$, $p=0.01$) but not with CIEDE2000 ($r=0.07$, $p=0.32$).

ΔE* obtained the best colour discrimination between the resected areas of malignant brain tumours and the background when compared to CR and CIEDE2000. Therefore, ΔE* may be the best formula to help neurosurgeons distinguish the colour differences when operating malignant brain tumours with 5-ALA fluorescence [1)].

1)
Szmuda T, Ali S, Słoniewski P. Comparison of color difference formulas to best distinguish resected areas of malignant brain tumors from their background using 5-aminolevulinic acid fluorescence. Folia Morphol (Warsz). 2020 Mar 24. doi: 10.5603/FM.a2020.0035. [Epub ahead of print] PubMed PMID: 32207850.