DETERMINANTS OF SPECT RESOLUTION AND CONTRAST USING A JASZCZAK PHANTOM

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Abstract

Background: Contrast and resolution are important parameters in Single Photon Emission Computed Tomography (SPECT) imaging. Increasing time and number of projection angles are methods to maximize contrast and resolution in clinical situations, however there is not much evidence as to which method is better.

Purpose: The objective of this research is to determine if increasing imaging time or imaging angles has a larger effect on image contrast and resolution in a controlled SPECT phantom scan.

Methods: A Jaszczak phantom was filled with 20 mCi of ^{99m}Tc and imaged ten separate times using common clinical SPECT protocol settings. After decay of the phantom (60hours), we filled the phantom with another 20mCi of ^{99m}Tc dose. The phantom was imaged 10 times with the same clinical protocol settings, except the time per image was increased. Likewise, after decay of the phantom the procedure was repeated increasing the number of imaging projections. On each trial, the phantom was assessed for contrast percentage on the larges cold sphere and smallest cold sphere using equation 1. Resolution was determined subjectively by examining the internal cold bars of the Jaszczak phantom which are of increasing known size throughout. The smallest set of bars distinguishable on the image was considered the resolution ability of that image.

$$\text{Eq. 1: } Contrast\ \% = \frac{counts\ from\ uniform\ area - counts\ in\ cold\ sphere}{Counts\ in\ uniform\ area} \text{ x } 100$$

We used a nonparametric Kruskal Wallis test to evaluate the ordinal resolution across trials. Contrast percentages in each trial were evaluated using Sharpiro Wilk tests and examination of QQ-plots to determine normality. If normality assumptions held, ANOVA was employed to examine differences in contrast percentage, however if normality failed, a nonparametric Kruskal Wallis test examined differences. A 5% chance of a type 1 error was presumed, and tests were computed using SAS 9.4.

Results: Increased projections and scan time both enhanced the resolution and contrast capability. (p=00005) However, there were no significant resolution differences between increasing projections or scan time. (p=0.9995) Likewise, there were no significant differences in contrast percentage of the largest cold sphere comparing baseline scans versus the increased projection or time scan. (p=0.0735) However, contrast did differ from the baseline scan on the smallest cold sphere. (p<0.0001) Interestingly, increasing projections decreased contrast on the smallest cold sphere 18.6% (95%CI: 15.0, 22.3; p<0.0001). Likewise, increasing time per image also decreased contrast on the smallest sphere by 6.8% (95%CI: 3.2, 10.5) when compared to baseline.

Conclusion: This study reveals that both contrast and resolution do change with increasing time and image projections. Increasing both time and projections from baseline enhanced resolution, but there was negligible difference between one or the other. Additionally, contrast of the smallest cold sphere seemed to suffer with increased time and image projections.

Relevance to Allied Health: We implement quality control to ensure our cameras are performing accurately to provide the best images for providers. Our images allow many Allied Health Professionals to select the best treatment plan for patients after reports are read thoroughly and distributed by reading radiologists.