Impact of CT Reconstruction Kernel on Radiomic Features and Fatty Infiltration Measurements in Shoulder Muscles

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INTRODUCTION: The quality and integrity of the shoulder muscles and bones can impact shoulder arthroplasty outcomes. In the current clinical practice, the evaluation of muscle quality is typically performed through visual inspection of medical images, such as CT scans, and subjective assessment of features such as muscle atrophy or fatty infiltration, scales like the Goutallier classification [1]. Previous studies have proposed more objective and quantitative metrics for assessing fatty infiltration [2]. This is often defined by identifying fat voxels that fall within a predefined grey-scale intensity range, and then normalizing this count to the total number of voxels within the segmented muscle volume. With the growing field of radiomics, recent studies have quantified such characteristics of the shoulder muscles and explored their associations with outcomes after shoulder arthroplasty [3]. These studies suggest that radiomics may provide a more comprehensive and objective characterization of muscle quality compared to conventional, subjective assessment methods. However, since radiomics features are derived directly from voxel intensities and their spatial distribution, they are susceptible to variations introduced by imaging acquisition and reconstruction parameters. In particular, the choice of reconstruction kernel (e.g., sharp vs. soft) can substantially influence feature stability and reproducibility. The aim of this study is to evaluate the impact of CT reconstruction kernel on radiomics features extracted from shoulder muscles and to compare this variability with that observed in quantitative fatty infiltration measurements.

METHODS: Deidentified preoperative CT scans were collected from a database compiled for preoperative planning and navigation in shoulder arthroplasty patients. Patients with scans reconstructed using two different kernels were identified and included. For each patient, the deltoid muscles were segmented using a previously developed automated segmentation model, after which both deterministic fatty infiltration (FI) and radiomics features were quantified. A total of 93 intensity-related radiomics features (18 first-order and 75 second-order features) were extracted using PyRadiomics (version 3.0.1). In addition, FI was calculated by dividing the number of voxels within the range of –190 to –30 Hounsfield units (HU, representing fat) by the total number of voxels between –190 and 50 HU (representing both fat and muscle). Finally, Pearson correlation coefficients were computed to evaluate the agreement of radiomics features and deterministic FI between the two reconstruction kernels.

RESULTS: Scans from forty-two patients were eligible for inclusion in the study, however, seven were excluded due to poor segmentation quality of the deltoid. The remaining thirty-five patients (23 female; mean age of 70 ± 7 years) were included in the analysis. From the collected images, 42 were acquired on Siemens scanners, 24 on GE, and 4 on Toshiba. A total of 33 different reconstruction kernels were used, with "Standard" being the most frequent (11 images), followed by "Bone" (7 images) and "BonePlus" (5 images). The deterministic FI and radiomics features derived from different kernels were paired and Pearson correlations between measurements were calculated. Deterministic FI values demonstrated weak and non-significant correlation ($r = –0.17$, $p = 0.33$). In contrast, among the 93 radiomics features, 11 demonstrated strong correlations ($r > 0.8$, $p<0.05$), indicating consistency across kernels. Figure 1 illustrates the scatter plots and correlation coefficients for these features.

DISCUSSION: Our study demonstrates that CT reconstruction kernels significantly influence certain quantitative imaging metrics, particularly the commonly used deterministic FI. While FI showed poor reproducibility across the same patient images reconstructed with different kernels, a subset of radiomics features remained highly consistent, suggesting they may represent more robust alternatives. These findings highlight both the vulnerability of traditional voxel-based measures to imaging variability and the potential of radiomics to provide stable, quantitative descriptors of muscle features in the setting of shoulder arthroplasty. Future work should seek to validate if these robust alternatives are in fact representative of muscle quality.

Although limited by sample size and retrospective design, this study highlights the importance of standardizing imaging protocols and identifying kernel-invariant radiomics features. Another limitation is that it does not separate the effect of reconstruction kernels on segmentation performance versus feature quantification. Future work should address this by applying the same segmentation mask across images reconstructed with different kernels. In addition, larger prospective studies are needed to validate kernel-robust features and investigate their associations with both traditional metrics like deterministic FI and clinical outcomes, with the ultimate goal of developing reproducible imaging predictors that enhance patient evaluation and treatment planning.

SIGNIFICANCE/CLINICAL RELEVANCE: Variability in CT reconstruction kernels can undermine the reliability of commonly used measures such as fatty infiltration, potentially leading to inconsistent assessments of muscle quality in shoulder arthroplasty patients. Identifying kernel-robust radiomics features may enable the development of reproducible imaging biomarkers that improve preoperative evaluation and better support clinical decision-making.

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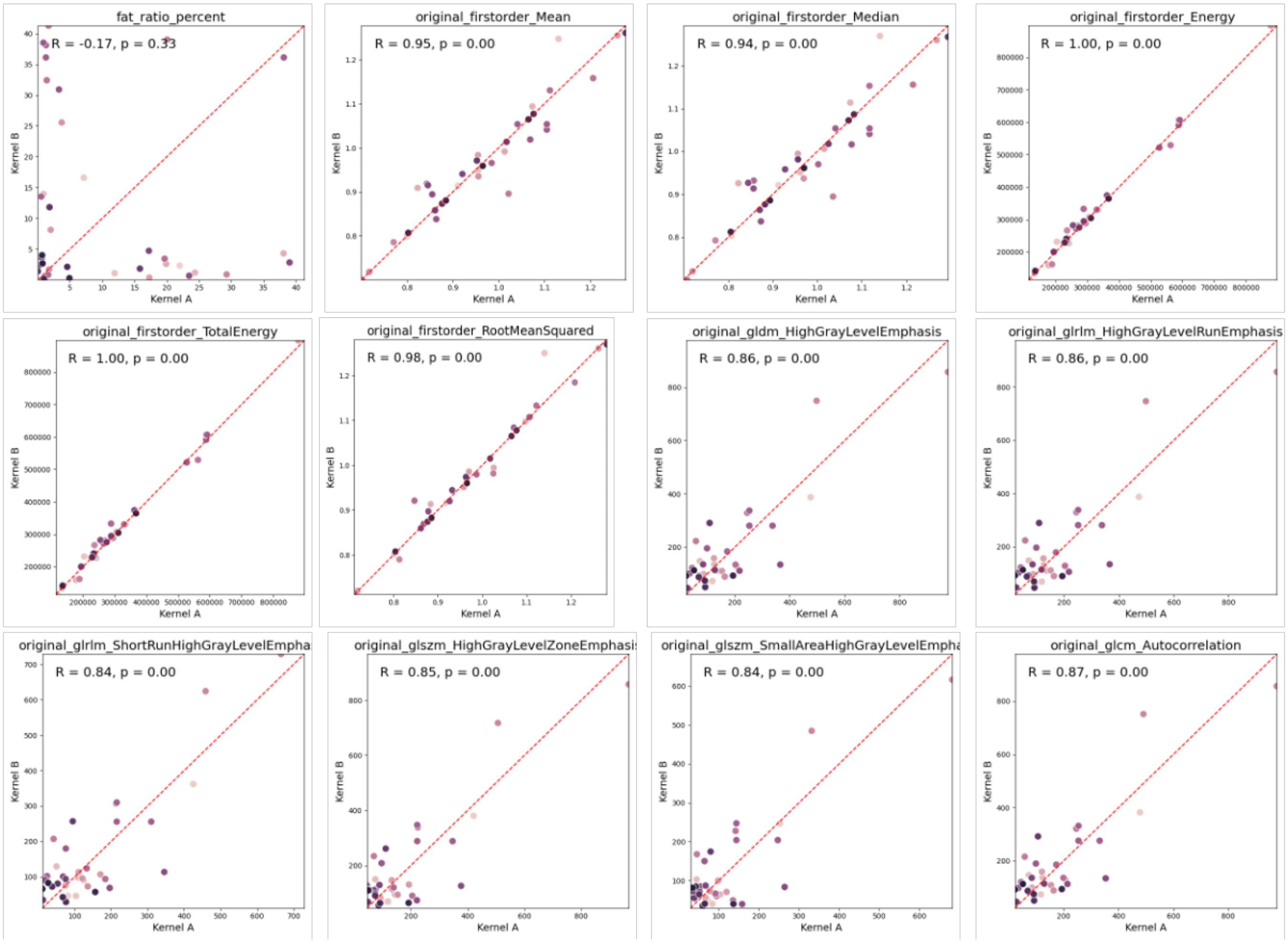

Figure 1: First- and second-order radiomics features that were robust and less affected by variations in CT reconstruction kernels.