Accuracy of Tumor Volume and Growth Determination Using MR Imaging and Caliper Measurements

J. V. PANETTA, D. CVETKOVIC, L. CHEN and C.M.C. MA
Fox Chase Cancer Center, Philadelphia, PA

JULY 12–16 2020 VIRTUAL JOINT AAPM | COMP MEETING
EASTERN TIME [GMT-4]

INTRODUCTION

Preclinical imaging is commonly used in longitudinal studies to test the efficacy of novel treatments. Caliper measurements provide the benefit of speed and cost, but are associated with high variability. MR measurements are proven to be useful for small animal tumor measurements, providing high spatial resolution and improved uncertainty at the cost of greater imaging time.

AIM

The purpose of this study is to investigate the accuracy of tumor volume and growth determination using MR imaging/contour delineation and caliper measurements. Without a known ground truth of tumour volume, we hypothesize that using an imaging modality with high resolution and the ability the measure tumor volume in three dimensions improves the accuracy of tumour growth measurements in longitudinal studies.

METHOD

- Mice with flank tumors (n = 31 tumors) with a large range in size (18 – 152 mm^3) were grouped into four treatment groups and monitored using caliper measurements and weekly MR images on a GE Signa 1.5T MR scanner.
- Tumor volume was measured using three methods.
- The first and second methods (Caliper Linear Measurement and MR Linear Measurement methods) measured two perpendicular dimensions of the tumors using the calipers or the MR images, and calculated the volume using a common formula found in the literature.
- The third method (MR Contouring method) involved contouring the tumors on each slice of the MR image using a contouring GUI.
- Tumor volume and tumor growth (the ratio of tumor volume 2 weeks after treatment to that near the day of treatment) were compared using these methods

RESULTS

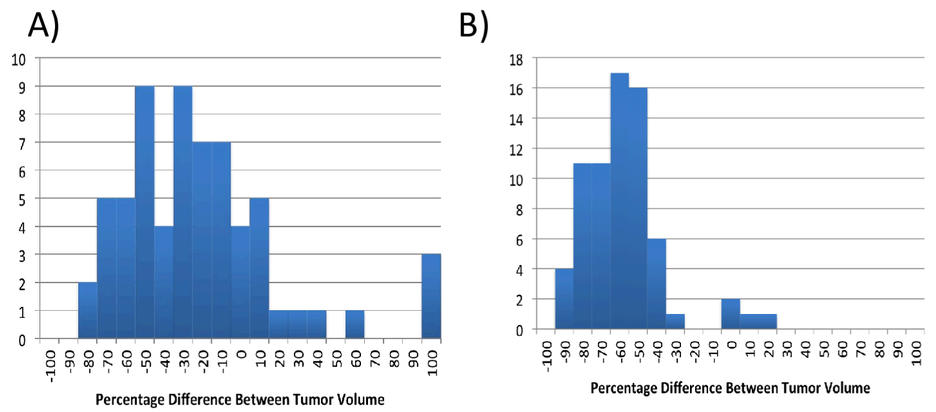

Figure 1: Percentage difference between tumor volume measured using A) MR Contouring and Caliper methods and B) MR Contouring and MR Linear Measurement methods.

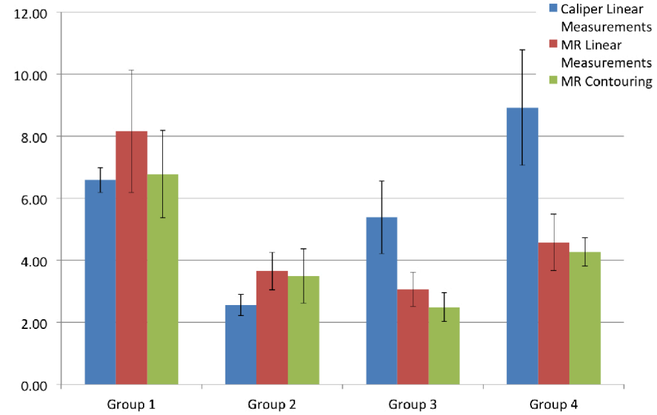

Figure 2: Average tumor growth of the various treatment groups when using the different measurement methods.

- Figure 1 shows histograms of the percentage difference between tumor volume measured using the A) MR Contouring and Caliper methods, and B) MR Contouring and MR Linear Measurement methods. Percentage differences between the two MR methods are more closely clustered together compared to the differences between the Caliper and MR Contouring methods.
  - Tumor volume measured by the MR Linear Measurement and Caliper methods were usually lesser than that measured using the MR Contouring method, although the differences between the measurements using MR methods were more closely clustered together (σ=26%) compared to the differences between the Caliper and MR Contouring methods (σ=66%).
- Figure 2 shows a plot comparing the average tumor growth of the various treatment groups when using the various measurement methods. The Caliper method results in significant differences in tumor growth compared to the two MR methods. The MR methods statistically agree with one another, but still show large differences compared to one another.
  - The average tumor growth measurements obtained using the two MR methods statistically agreed with one another, although results disagreed by as much as 18.7%

CONCLUSIONS

This study indicates that the measurement method significantly affects the accuracy of tumor volume as well as tumor growth determination, and that contouring on each slice of the MR scans cannot in general be substituted by methods that measure two dimensions of the tumor.

We therefore highlight the benefit of using MR scans and contouring each slice of the MR images when determining tumor volume and calculating tumor growth, despite the added effort in doing so relative to that of measuring linear tumor dimensions.

CONTACT INFORMATION

Email: joseph.panetta@fccc.edu