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Image comparison of 3 different known geometrical shapes contoured on different imaging modalities on a phantom for stereotactic frameless procedure of AVM

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Objective: To compare the accuracy of 3 different known geometry objects drawn on CT (Computed tomography), MR (Magnetic Resonance) and DSA (Digital subtraction Angiography) images on a phantom with stereotactic frameless mask on Brainlab iPlan RT Image contouring workstation.

Methods and material: A phantom study was done for images registration and contouring accuracy for SRS case of Arterio-Venous Malformation (AVM) treatment. Phantom was designed in such a way that it contains 3 different shapes; 1. Spherical plastic ball filled with water, 2. Egg shaped (ellipsoidal) gel ball, 3. Irregular electron p-orbital shaped (px, py, pz) structure made with olive oil capsule. All three different shapes material were chosen in such a way that all contains hydrogenous material which could be imaged in MR machine and at the same time DSA and CT images could also be acquired of the same material.

DSA images were taken with two standard antero-posterior and lateral pair. CT was taken with 1 mm slice thickness in Philips CT scanner, and MR was taken in sagittal section with 3 Tesla MRI machine (Philips). All images were imported in iPlan RT image (v 4.1.1) contouring workstation.

CT images were localised using Brainlab head and neck localiser, afterward standard x-Ray pair were imported, localised with CT-Angio localiser and at last MR images were imported, fused with CT images. All the three imaging modalities CT, MR and x-Ray pair were fused and localised. Thus, contouring on any imaging modalities would reflect on other modalities also.

All different objects were contoured independently on MRI, CT and DSA and their volumes were measured and noted. Afterward intersecting volumes between all three structures were measured by creating intersecting objects between images over all the 3 imaging modalities (CT, MRI and DSA). So total 9 single objects images and 9 intersecting images were generated and their volumes were calculated. The intersection volumes denoted the accuracy between two different imaging modalities that two volumes look like similar on both.

Result: It was found that standard x-Ray pair could not form irregular images, they were good for spherical and ellipsoidal objects but for irregular tumor they were providing only outer boundaries and the actual tumor could be drawn on 3-dimensional set of images obtained from MR and CT.

The volume of spherical ball in CT, MR and DSA image were 37.4 cc, 30.9 cc, 32.9 cc respectively and the volumes of ellipsoidal ball were 62.4 cc, 57.2 cc, 51.6 cc respectively and volume of p-shaped orbital structure were 5.9 cc, 3.2 cc and 6.6 cc respectively.

The intersection volumes between MR and CT for ellipsoidal, spherical and p-orbital shape were 56.8 cc, 30.7 cc, and 2.5 cc respectively. The intersection volume for MR and DSA images for ellipsoidal, spherical and p-orbital shape were 49.7 cc, 30.4 cc, 2.1 cc respectively. The intersection volume in CT and DSA for ellipsoidal, spherical and p-orbital shape was 51.4 cc, 32.9 cc, 3.7 cc respectively.

Conclusion: The study concluded that for contouring of irregular tumor on DSA will not give the precise picture of tumor, although it can provide an envelope around tumour which can further be contoured on MRI and CT imaging modalities more accurately.

Country

India

Institution

Fortis Memorial Research Institute Gurgaon Haryana

Primary author: GIRI, Upendra (Fortis Memorial Research Institute)

Co-authors: MUNSHI, Anusheel (Fortis Memorial Research Institute Gurgaon Haryana); MOHANTI, Bidhu (Fortis Memorial Research Institute Gurgaon Haryana); SARKAR, Biplab (Fortis Memorial Research Institute Gurgaon Haryana); JASSAL, Kanan (Fortis Memorial Research Institute Gurgaon); GANESH, Tharmar (Fortis Memorial Research Institute Gurgaon Haryana)

Presenter: GANESH, Tharmar (Fortis Memorial Research Institute Gurgaon Haryana)

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