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Te Whatu Ora
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Evaluation of the Uncertainty in Determining Size and Location of Arteriovenous Malformations Volumes Using Brainlab Element's Cranial Vascular Fusion and Contouring Tools

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Purpose

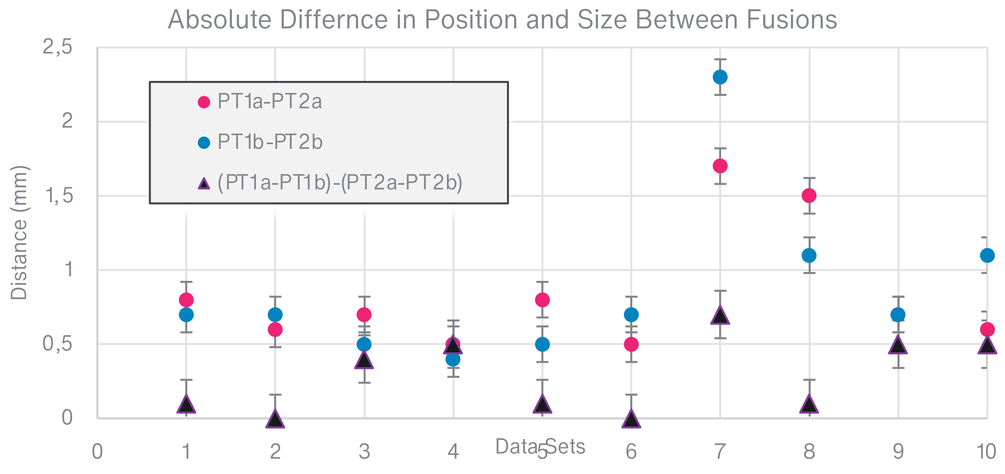
Previously Arteriovenous Malformation's (AVM) location is outlined using Digital Subtraction Angiography Images (DSA) and are then transferred on to a planning Computed Tomography (CT) scan using fiducial markers on a frame attached to the patient's head. Since moving to Brainlab's (BL) frameless system, 2 orthogonal DSA images are fused with the 0.7mm slice Computed Tomography Angiogram (CTA) data set using 5 degrees of freedom (1 for scaling, 2 translational and, 2 for rotational). The fusion is based on the arterial system of the patient. The nidus outlined on DSA images are then contoured on the CTA. In this study we are trying to identify what the uncertainty is in the size and location of the nidus structure as this depends on the fusion of the CTA and DSA and the ability of the user to tell if the fusion is adequate.

Materials and Methods

We analysed 10 patient's data sets. 2 fusions were created from each CTA and DSA data sets. An analysis of the fusions showed that some had very slight misalignment even though we tried to get the best fusion possible. These fusions with visibly slight misalignment were categorised as "bad" and given stars ranging from * to ***. Where there was no misalignment visible the fusion was considered "good" and given ****.
Then in the "smart Brush" application two very small areas (less than 0.001cc) in or close to the nidus were outlined by looking at an area on the DSA (PT1a, PT1b). The same two points were identified and outlined using the second fusion (PT2a, PT2b). The centre coordinates of these very small areas that approximate a point were found on the CTA.
The distance between the same points for the two fusions gave an estimate of the uncertainty in location ([PT1a-PT2a]and [PT1b-PT2b]). Comparing the distances between the two points (a and b) for each of the fusions (1 and 2) gave an estimation of the uncertainty in the size of the nidus ([PT1a – PT1b] vs [PT2a-PT2b]).

Results

The same point was contoured 4 times on the same fusion to calculate the Type A error in locating the point was determined to be 0.12mm and for the difference in size for 2 fusions is 0.16mm.
For fusions on the same data set where both fusions were considered "good" (data sets 1-6), the average difference between points (PT1a-PT2a) is 0.62mm. Where one fusion was "good" and the other "bad", it is 1.21mm (data sets 7-10).
The biggest difference in length we had was 0.7mm and was between fusions that were considered one to be "good" and the other "bad".



Conclusion

Depending on whether a good fusion was achieved or not, the Planning Target Volume (PTV) margin may need to be adjusted accordingly or customized for individual patients. If a good fusion was achieved, then a 1 mm PTV margin is adequate as we also need to consider localization using imaging and patient movement.