Quantitation of Brain changes seen on serially registered MRI in Normal Pregnancy and Pre-Eclampsia

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INTRODUCTION

Although many reports describe cerebral edema in pre-eclampsia there has also been one report of cerebral atrophy(1). We previously described physiological changes in the brain indicative of reversible cerebral atrophy, both in pre-eclampsia and normal pregnancy (2,3), using serial 3D subvoxel image registration (4). Our aim in this study was to quantify these changes using a semiautomated segmentation and quantitation program to make a detailed comparison of changes in the brain and ventricules.

PATIENTS AND METHODS

Five subjects with Pre-eclampsia [mean age 32.2 (range 29-38)] and five aged matched with normal pregnancy [mean age 31 (range 22-38);NS] were entered into the study. All were imaged in the third trimester of pregnancy, six weeks (early post partum) and between 5½ and 15 months (late post partum) after delivery. All imaging studies were performed on a 1.0T Picker HPQ system. 3D T_1 weighted RF spoiled images (TR = 21 msec, TE = 6 msec) were obtained with a matrix of 152 x 256 x 114, 25 cm FoV and 1.6 mm slice thickness. An automated knowledge based segmentation program was used to isolate the brain prior to image registration (5). In each case the initial pre-delivery scan was used as the baseline image to which all subsequent images were matched. Subtraction images were obtained in each study. Changes observed visually in the brain and the ventricles on the subtraction images were graded by two observers using a scale of -4 (maximum reduction in size) to +4 (maximum increase in size) in both the pre-eclamptic and the normal pregnant group. Comparisons were made between the baseline pre delivery scans and both the early and late post partum scans.

QUANTITATIVE ANALYSIS:

Both brain and ventricular volumes were measured separately in each case. All images were intensity scaled to match the baseline data sets using factors obtained from RoI measurements in homogeneous white matter areas of the brain in both hemispheres.

Ventricular Segmentation:

A contour was manually drawn around the ventricles (to include the lateral + third ventricles) on the pre-delivery scan. The contour was copied to all subsequent realigned follow-up images and each slice was checked to ensure the ventricular system was included on each data set. An intensity range to include CSF was calculated in each data set for each subject by measuring a RoI of 3-5 voxels in the lateral ventricles. The same CSF intensity range was used throughout. Ventricular volume measurements were then obtained using a ventricle segmentation and quantitation program developed in house (6).

Brain Segmentation:

The contour obtained to extract the brain prior to image registration was used. Manual adjustments were made to ensure only brain and CSF were included within the contour in each data set. The maximum signal intensity calculated for the CSF was used as the minimum threshold level in each data set. The maximum level was set to the highest signal intensity level of each data set. Volumetric measurements for brain with and without CSF were calculated using in-house quantitation programmes. Statistical analyses were carried out using the students statistical calculator program

RESULTS

The average grades of the change of the brain, in both groups ($\geq$+1.5), showed increases in size in both the early and late postpartum scans. For the ventricular system, the average grade of change ($\leq$-2.6) indicated decreases in size in both post partum scans in both groups.

QUANTITATIVE ANALYSIS:

Brain

There was an increase in size of the brain measured at early and late post partum compared to the pre delivery scan which was highly statistically significant in both pregnancy groups ($p<0.005$). Also there was a highly significant increase in size between the early and late post partum scan in both groups ($p<0.015$). There was a statistically significant decrease in brain size when comparing the pre-eclampsia group to the normal pregnancy group, in the pre-delivery and early post partum scans. However there was no significant difference between the two groups on the late post partum scans.

Ventricles

There was a statistically significant decrease in ventricular size on both the early and late post partum scan compared to the pre-delivery scan in both the normal pregnancy and pre-eclampsia groups ($p<0.017$). There was no significant difference between the early and late post partum scans nor between the two groups.

CONCLUSION

The scoring of the changes within the brain suggested reversible atrophy which was consistent with our previous findings in both normal pregnancy and pre-eclampsia groups. We were also able to quantify these changes and demonstrate statistically significant increases in brain size in all post partum scans. A new finding was the fact that the brain was significantly smaller in the pre-eclampsia group than in the normal pregnancy group prior to delivery and at the early post partum stage. These differences were no longer present by the late post partum stage which may be due to two of the pre-eclampsia subjects having a reduction in brain size in the late post partum scan.

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