20th World Congress in Fetal Medicine

Motor and urological outcomes following fetal surgery for spina bifida

Mufti N, Chappell J, Aertsen M, Ebner M, Fidon L, Gaunt T, Pegoretti Baruteau K, Sokolska M, Banh S, Irzan H, Mastrodima-Polychroniou S, Bredaki FE, Sacco A, Kendall GS, Atkinson D, Vercauteren T, Ourselin S, Thomson D, De Vloo P, De Catte L, Demaerel P, Devlieger R, Deprest J, David AL, Melbourne A
University College London, London, United Kingdom

Objective

To correlate motor and urological outcomes at one-year of age with longitudinal fetal brain imaging analysis following open spina bifida (OSB) repair using post-acquisition MRI processing advances which quantified volume, surface area, shape and gyrification.

Methods

MRI images of 29 OSB fetuses before fetal surgery (<24 weeks), one week and six weeks post-surgery, were compared to 36 age-matched controls (21^{+2}-36^{+2} weeks). Automated super-resolution reconstruction provided 3D isotropic brain volumes. White matter, cerebellum and ventricles were automatically segmented and manually refined; cerebral and cerebellar volume growth/week, surface area, and volume/surface area ratio change per week, were quantified. Shape parameter an indication of brain complexity, was defined as volume/surface area. Mathematical markers (shape index (SI), and curvedness) were used to measure gyrification. These parameters where further correlated with motor and urological outcomes at one-year of age. Gross motor outcomes were adapted from the Bayley Scales of Infant and Toddler Development and were categorised into the following four groups from worst to best: group 1 (rolling or unable to sit, sitting with support), group 2 (sitting independently), group 3 (crawling), group 4 (pulling to stand, standing with support). Urological outcomes included: urological complications (e. g. , neuropathic bladder, hydronephrosis, scarring, reflux, recurrent urinary tract infections), need for clean intermittent self-catherisation (CISC), and/or anti-cholinergic drugs.

Results

In infants with worse motor outcomes, ventricular volume growth/week was increased in comparison to controls one-week post-surgery. This was shown in group 1 ((5586, IQR: 3506.9-8388.8 mm3/week) vs (681.0, IQR: 354.2-763.62 mm3/week), p=0.001), group 2 ((4805.92, IQR: 3768.74-5665.5 mm3/week) vs (681.02, IQR: 354.2-763.6 mm3/week), p<0.001), and group 3 ((2969.34, IQR: 1658.7- 6611.1 mm3/week) vs (681.02, IQR: 354.2-763.6 mm3/week), p=0.01). In infants with worse motor outcomes, there was also an increase in curvedness/week versus controls one-week post-surgery. This was shown in group 1 ((0.184, IQR: 0.124-0.279 mm-1/week) vs (0.072, IQR: 0.059-0.081 mm-1/week), p=0.034), group 2 ((0.145, IQR: 0.105-0.207 mm-1/week) vs (0.072, IQR: 0.059-0.081 mm-1/week), p=0.045), and group 3 ((0.145, IQR: 0.094- 0.252 mm-1/week) vs (0.072, IQR: 0.059-0.081 mm-1/week), p=0.033). The rate of curvedness per/week was thereafter decreased in the long-term time period for group 2 versus controls (p=0.029). In infants with urological complications at one-year of age, ventricular volume/week was increased in comparison to controls one-week post-surgery ((4243.9, IQR: 2509.3-6226.6 mm3/week) vs (681.02, IQR: 354.2-763.6 mm3/week), p<0.001), and six-weeks post-surgery ((2582.7, IQR: 1578.4-3320.26 mm3/week) vs (580.05, IQR: 184.1-1543.4 mm3/week), p=0.041). This was different to fetuses without urological complications at one year of age where the ventricular rate was only increased in comparison to controls one-week post-surgery (p<0.001). For infants requiring CISC at one-year of age, white matter shape parameter/week was reduced in comparison to controls six weeks post-surgery ((0.061, IQR: 0.047-0.112 mm/week) vs (0.159, IQR: 0.103-0.244 mm/week), p=0.032).

Conclusion

One week after fetal surgery, infants with worse motor outcomes had increased ventricular growth/week and increased curvedness/week corresponding to increased gyrification in comparison to controls. Six weeks post fetal surgery, infants with urological complications showed increased ventricular dilation/week, whilst those requiring CISC had reduced white matter shape parameter/week in comparison to controls.

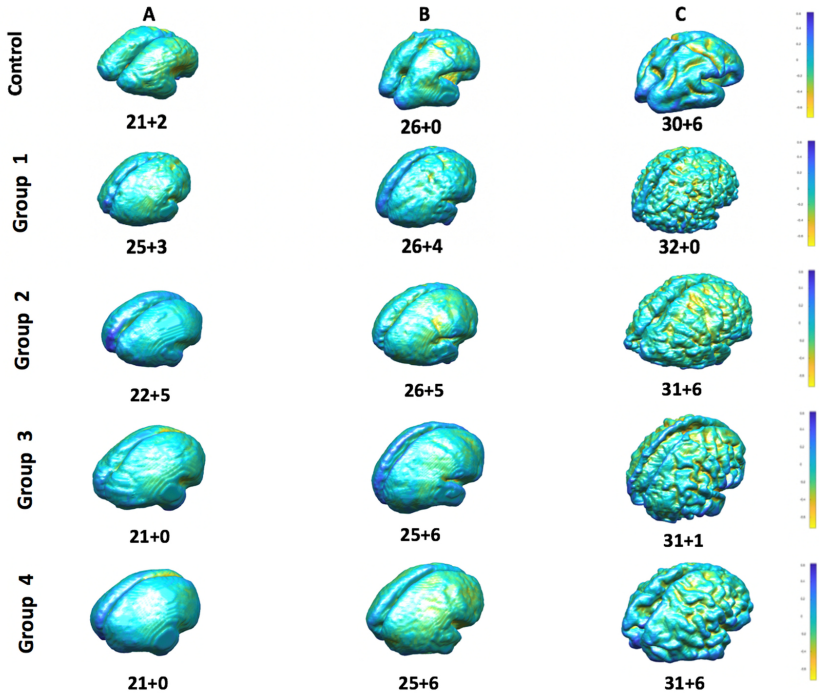

Figure 1 Mesh display (with accompanying colour scale (right)) of shape index for unmyelinated white matter of a control fetus (top row) compared to open spina bifida fetus brains with a resulting infant one-year motor outcome in group 1 (second row), group 2 (third row), group 3 (fourth row) and group 4 (bottom row). This is separated into three time points (A: before fetal surgery, B: approximately one week after fetal surgery, and C: approximately 6 weeks after fetal surgery).