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Fetal diffusion tensor imaging in case of short corpus callosum

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Objective

Short corpus callosum (SCC) is defined as a generalized hypoplasia with intact morphology. Its management is challenging because there is no consensual definition or charts on which to base diagnosis and data regarding outcomes of SCC are scarce. Diffusion Tensor Imaging (DTI) evaluation of corpus callosum (CC) have suggested that the presence of Probst Bundles in SCC could help to differentiate between callosal dysplasia and variant of normal CC development. We hypothesized that the DTI metrics, which reflects the integrity of the microstructural of the white matter (WM), would be altered in SCC with Probst bundles (PB) as compared to SCC without PB or normal CC and could help to redefine CC abnormalities. The objective of our study was to compare the DTI metrics in the CC in fetuses with SCC with normal CC and between SCC with and without PB.

Methods

This was a retrospective study of fetuses referred to the Necker Hospital (Paris, France) for MRI evaluation of an apparently isolated SCC by sonography between 01/2016 and 12/2022 (IRB 0011928). MRI scans were performed on a 1.5T General Electric Sigma system (GE Healthcare, Waukesha, WI, USA). T2 axial and sagittal sequence of the fetal brain were used to measure the length and the thickness of the CC. 16-directions DTI axial brain sequences were performed to identify the presence of Probst bundles and to generate quantitative imaging metrics (Fractional Anisotropy [FA], Apparent Diffusion Coefficient [ADC]) in the entire CC, the genu, the body and the splenium. Cases with associated brain abnormalities at MRI were excluded. All cases were matched for GA with controls at a 1: 3 ratio. These were normal fetuses included in the LUMIERE on the FETUS trial (NCT0414206) who underwent the same MRI-DTI evaluation of the brain. Comparison between short and normal CC and between SCC with PB and without PB were performed and adjusted for potential confounders.

Results

22 SCC were included and compared to 66 fetuses with normal CC. In 10/22(45.4%) SCC, PB were identified. Dimensions of the CC were significantly lower in case of SCC compared to normal CC (all $p<0.01$) as expected. In the entire cohort of SCC, FA values were significantly lower compared to normal CC in the entire CC (0.22[0.19-0.28] vs 0.26[0.22-0.32], $p<0.01$), the genu (0.22[0.15-0.29] vs 0.27[0.22-0.33], $p<0.01$), the body (0.22[0.18-0.27] vs 0.26[0.22-0.34], $p<0.01$) and the splenium (0.23[0.16-0.30] vs 0.29[0.22-0.38], $p<0.01$). In SCC with PB, FA values were significantly lower compared to SCC without PB in the entire CC (0.21[0.19-0.24] vs 0.24[0.22-0.28], $p=0.04$), the genu (0.21[0.19-0.24] vs 0.24[0.17-0.29], $p=0.04$), the body (0.21[0.18-0.23] vs 0.23[0.21-0.27], $p=0.01$) and the splenium (0.22[0.16-0.30] vs 0.25[0.20-0.29], $p=0.02$). Also, the ADC values were significantly higher in the SCC with PB compared to SCC without PB (all $p<0.05$). In SCC with PB, all FA values were significantly lower and the ADC was significantly higher compared to normal CC (all $p<0.05$). In SCC without PB, there was no difference in FA and ADC compared to normal CC (all $p>0.05$).

Conclusion

Fetal DTI evaluation of the SCC showed that the FA was significantly lower and ADC significantly higher compared to normal CC in those cases with PB. These differences may highlight alterations of the WM microstructure in SCC with PB. On the opposite, isolated SCC without PB does not demonstrate significant changes in diffusion parameter and may only represent normal variant.