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3D volume ultrasound assessment of caesarean section scar niche and cervix in pregnant women

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Objective

To evaluate the reproducibility of a standardised three-dimensional (3D) ultrasound volume analysis protocol of caesarean section (CS) scar niche and cervix assessment in pregnant women with a history of previous late first stage or second stage CS.

Methods

This was a prospective single centre cohort study on women with a singleton pregnancy and one emergency CS at ≥ 8cm cervical dilatation who attended a specialist preterm birth prevention service at University College London Hospital, UK (2019-2022). 3D volumes of the lower uterine segment and cervix were acquired at 14-24 weeks' gestation as per study protocol. Volume acquisition was done in a mid-sagittal lower uterine and cervical plane, and the level of the internal os was identified using colour Doppler and uterine artery visualisation in the paracervical region. Sonographic volume processing was done by two experienced operators using virtual organ computer aided analysis (VOCAL) function on 4D View 18 Software (GE Healthcare Austria). 2D niche measurements taken on 3D volumes including length, depth, width, distance to internal and external os, residual and adjacent tissue thickness were recorded. Niche and cervix volumes were calculated using manual contouring in 6 reference planes, at 30 degree angles from each other and niche/cervix ratio was determined for each participant. Statistical analysis was performed using IBM SPSS Statistics v27. Level of agreement for categorical variables was expressed using intraclass correlation coefficient (ICC). Bland Altman method was employed to assess the reproducibility of numerical variables, using one sample t-tests with a significance level of 0.05 to calculate the mean differences between individual measurements.

Results

To achieve the desired statistical power, 52 participants were included. The median interval between the index CS and 3D volume acquisition was 3 years. There was full agreement between the two operators regarding CS scar niche visualisation on 3D volumes in all cases. The intraobserver level of agreement on niche classification in relation to the internal os was 100%. The interobserver ICC for assessment of niche position relative to the internal os was 0.98 (95% CI 0.97-0.99, $p<0.05$). The intraobserver level of agreement for niche volume was excellent at ICC of 0.94; 95% CI 0.90 - 0.96; $p<0.001$ and 92% (48/52) of all differences measured ≤ 0.25 cm3. The corresponding interobserver level of agreement for niche volume was good at ICC of 0.78; 95%CI 0.62 - 0.87; $p<0.001$ and 88% (46/52) of measurements' differences were ≤ 0.25 cm3. The ICC for niche/cervix ratio were 0.94 (95% CI 0.90, 0.96; $p< 0.001$) and 0.79 (95% CI 0.63, 0.87; $p<0.001$) for intra- and interobserver assessment, respectively.

Conclusion

This prospective study demonstrates that 3D CS scar sonographic features can be determined in pregnancy at a high level of reproducibility. The study validates a protocol for 3D CS scar niche assessment that can be used to guide future research studies into the association between CS scar and adverse pregnancy outcomes, such as late miscarriage or spontaneous preterm birth.