

Estimating the error in spectral analysis of fetal heart rate variability

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ESTIMATING THE ERROR IN SPECTRAL ANALYSIS OF FETAL HEART RATE VARIABILITY

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ABSTRACT

The fetal heart rate (FHR) is regulated by the autonomic nervous system (ANS) and changes in FHR are related to changes in autonomic regulation. Valuable information about fetal distress during labor could thus be obtained from analysis of FHR variability. To monitor changes in sympathetic and parasympathetic activity of the ANS, spectral analysis can be used [1]. However, spectral analysis is often disturbed by artefacts in the FHR recordings. Although it is possible to correct for these artefacts by linear interpolation of heartbeats, the interpolation itself will also affect the spectral analysis. Therefore, information on the reliability of calculated spectral powers is required to use spectral analysis of FHR variability in clinical practice. However, it is currently unclear how artefact correction affects the spectral analysis.

In this study, an analytical expression is derived for the error in spectral analysis of FHR variability that is caused by artefact correction. The spectral analysis is based on the Continuous Wavelet Transformation (CWT), which provides simultaneous time and frequency information [2]. With the CWT it is possible to estimate the error in spectral power at each moment in time, using the temporal information on the location of interpolated heartbeats. From this instantaneous error, the total error in spectral power of a certain frequency band can be estimated.

To compare the estimated error in spectral power to the actual error, a set of 2500 FHR recordings is created with varying levels of artefact correction (ranging from 5% to 50%). Spectral powers are calculated for the low frequency band (LF, 0.04-0.15Hz) and the high frequency band (HF, 0.4-1.5Hz). Results are obtained as the difference between the actual and estimated error, relative to their theoretical power. The difference between actual and estimated error was $-8\pm 9\%$ and $-12\pm 19\%$ for LF and HF power, respectively. The negative sign indicates that the error is mostly overestimated and the estimation is on the safe side.

The presented method allows clinicians to assess the reliability of spectral analysis of FHR recordings that are corrupted by artefacts. The results show that the error in LF and HF power is estimated reasonably well. Future research should focus on how this information can be used in the clinic.

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