3D Balanced Fast Field Echo (3D bFFE)

3D Balanced Fast Field Echo (3D bFFE) and **Balanced Steady-State Free Precession (bSSFP)** are essentially the same MRI sequence but are referred to differently depending on the manufacturer of the MRI system:

- **3D Balanced Fast Field Echo (3D bFFE):** Used by Philips. - **Balanced Steady-State Free Precession (bSSFP):** A generic term often used by researchers or clinicians. - **Other Vendor-Specific Names:**

1. **TrueFISP**: Siemens.
2. **FIESTA**: General Electric (GE).
3. **Balanced SARGE**: Canon/Toshiba.

These sequences work on the same principle of balanced gradient waveforms to maintain steady-state magnetization and are used interchangeably in clinical practice depending on the MRI system.

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1. Clinical Application and Purpose

1. All vendor-specific names of **bSSFP** provide excellent visualization of fluids (e.g., CSF, blood) and are highly effective for neuroimaging, cardiac imaging, and vascular studies.
2. The actual **clinical utility** depends on your purpose:
    1. For **CSF flow or aqueductal stenosis:** Any bSSFP-based sequence will suffice.
    2. For **motion-sensitive areas (e.g., cardiac):** Systems with better motion-correction capabilities may be preferred.

2. MRI System Availability

1. If your facility uses Philips scanners, 3D bFFE will be implemented.
2. If Siemens systems are used, the TrueFISP equivalent is preferred.
3. All vendors offer similar quality, with minor differences in implementation and naming.

3. Imaging Protocol Optimization

1. The performance of the sequence depends on how well it is optimized for the specific clinical indication:
    1. Resolution.
    2. Signal-to-noise ratio (SNR).
    3. Banding artifact correction.

4. Artifact Management

1. Different systems may perform better in managing artifacts like magnetic field inhomogeneities or susceptibility effects.
2. For example:
    1. Siemens TrueFISP is known for its efficiency in correcting banding artifacts in some settings.
    2. Philips 3D bFFE offers flexibility in specific neuroimaging tasks.

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Conclusion - **Use the sequence available on your system.** All balanced steady-state free precession sequences (bSSFP, 3D bFFE, TrueFISP, FIESTA) are effective and interchangeable with slight optimizations based on the manufacturer's software. - Focus on **protocol customization and artifact management** rather than the name of the sequence.

Prospective observational studies with a technical development focus

No dedicated platform exists for quantifying pressure differences across the aqueduct (ΔP), and no research has been conducted on the impact of breathing on ΔP. A study aims to develop a post-processing platform that balances accuracy and ease of use to quantify cerebral aqueduct resistance and, in combination with real-time Phase contrast magnetic resonance imaging, quantify ΔP driven by free breathing and cardiac activities.

Thirty-four healthy participants underwent 3D Balanced Fast Field Echo (BFFE) sequence and real-time phase contrast (RT-PC) imaging on a 3T scanner. Liu et al. used the developed post-processing platform to analyze the BFFE images to quantify the aqueduct morphological parameters such as resistance. RT-PC data were then processed to quantify peak flow rates driven by cardiac and free breathing activity (Qc and Qb) in both directions. By multiplying this Q by resistance, ΔP driven by cardiac and breathing activity was obtained (ΔPc and ΔPb). The relationships between aqueduct resistance and flow rates and ΔP driven by cardiac and breathing activity were analyzed, including a sex difference analysis.

The aqueduct resistance was 78 ± 51 mPa·s/mm³. The peak-to-peak cardiac-driven ΔP (Sum of ΔPc+ and ΔPc-) was 24.2 ± 11.4 Pa, i.e., 0.18 ± 0.09 mmHg. The peak-to-peak breath-driven ΔP was 19 ± 14.4 Pa, i.e., 0.14 ± 0.11 mmHg. Males had a longer aqueduct than females (17.9 ± 3.1 mm vs. 15 ± 2.5 mm, $p < 0.01$) and a larger average diameter (2.0 ± 0.2 mm vs. 1.8 ± 0.3 mm, $p = 0.024$), but there was no gender difference in resistance values ($p = 0.25$). Aqueduct resistance was negatively correlated with stroke volume and the peak cardiac-driven flow ($p < 0.05$); however, there was no correlation between aqueduct resistance and breath-driven peak flow rate.

The highly automated post-processing software developed in this study effectively balances ease of use and accuracy for quantifying aqueduct resistance, providing technical support for future research on cerebral circulation physiology and exploring new clinical diagnostic methods. By integrating real-time phase contrast MRI, this study is the first to quantify the aqueduct pressure difference under the influence of free breathing. This provides an important physiological reference for further studies on the impact of breathing on transmantle pressure and cerebral circulation mechanisms [1)]

While the findings are promising, they are preliminary, and further studies with larger sample sizes, disease populations, and longer follow-up periods are needed to validate these results and explore their clinical implications. The lack of a detailed description of the software's algorithms and technical specifications also limits the broader applicability of the approach, and future papers should provide more transparency in this area to ensure reproducibility and robustness. Nevertheless, this research opens the door to a better understanding CSF circulation and its potential role in neurodegenerative diseases.

[1]

Liu P, Owashi K, Monnier H, Metanbou S, Capel C, Balédent O. Transmantle pressure under the influence of free breathing: non-invasive quantification of the aqueduct pressure gradient in healthy adults. Fluids Barriers CNS. 2025 Jan 3;22(1):1. doi: 10.1186/s12987-024-00612-x. PMID: 39754238.