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CORR Insights®: Early Subsidence Predicts Failure of a Cemented Femoral Stem With Minor Design Changes

Don C. Beringer MD

Where Are We Now?

Consistently excellent clinical results and quality-of-life outcomes have been demonstrated with many cemented hip stems in THA during the past 40 years. Long-term series and systematic analyses

This CORR Insights® is a commentary on the article “Early Subsidence Predicts Failure of a Cemented Femoral Stem With Minor Design Changes” by Johanson and colleagues available at: DOI: 10.1007/s11999-016-4884-2.

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have supported the use of cemented stems as a legitimate alternative to noncemented stems from a clinical and economic perspective [1, 5, 8]. However, there are ongoing reports [3, 7] of higher than acceptable long-term aseptic loosening rates for some cemented stems, including the specific “shape-closed” stem design that was the subject of this study. Shape-closed stems, such as the Charnley prosthesis, are designed to achieve mechanical stability through geometry and surface characteristics that encourage rigid prosthesis-cement fixation and an evenly distributed cement mantle. These are distinguished from the highly polished, tapered design of the “force-closed” stems (eg, the Exeter stem), that convert millimeter-level stem subsidence into a long-term stabilizing force on the prosthesis and cement mantle.

In their study, Johnson and colleagues validated radiostereometric

analysis (RSA) as an early indicator of micromotion and as a correlate of long-term failure in a widely adopted femoral stem within the category of shape-closed stem designs. With RSA, they have confirmed that subsidence exceeding 0.15 mm at 2 years is a clinically relevant predictor of long-term aseptic loosening. More importantly, they demonstrate another instance where seemingly minor design alterations in an otherwise well-functioning cemented hip stem results in unacceptable long-term failure rates.

The mechanisms for stem failure discussed in this report, including changes in offset, stem size, and surface material, appear to be well supported by the data. The authors contribute additional evidence that the ongoing clinical success of cemented stems, particularly shape-closed designs, is highly sensitive to seemingly minor design modifications.

Where Do We Need To Go?

In view of the burden of revision surgery represented by these stem

D. C. Beringer MD (✉)
Mercer University School of Medicine,
1600 Forsyth St, Macon, GA 31201,
USA
e-mail: DBeringer@orthoga.org

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failures, several questions are raised by the study conclusions. First, what patient variables (aside from age and sex) can be identified such as BMI, activity levels, and bone density that might sensitize a cemented stem to failure with design modifications? This may influence patient selection for early clinical trials for evaluating the change. Second, is there enough accumulated data in the literature to suggest that a more rigorous and standardized process be implemented for early evaluation of the clinical performance of post-market cemented stems with any design modifications? Finally, should RSA alone, or in combination with other “early warning” protocols, become a standard for evaluating all changes in cemented stem design during the premarket or early-launch period?

How Do We Get There?

Before establishing any definitive recommendations for standardizing the approach to evaluating incremental stem design modifications, there is a need for further systematic evaluations of the basic science and clinical evidence. For example, a systematic approach to identifying categories of stem geometry, materials, and surface

characteristics that impact the frequency and magnitude of micromotion in cemented stems would be helpful. This may be accomplished through systematic reviews of finite element analysis studies in parallel with RSA and survivorship studies.

Finally, the current study underscores the need to validate alternative technologies to serve as an “early warning system” for identifying underperforming hip stems. While recognizing RSA as the current “gold standard” for detecting micromotion and predicting aseptic loosening, recent advances in wireless and nanotechnology sensors offers the potential for accurately monitoring motion, stress, and biochemical variables that correlate with aseptic loosening of a broad range of cemented hip stem designs [2, 4, 6]. Evaluating the safety, accuracy, cost, and accessibility of alternative component monitoring technologies would be some worthwhile next steps.

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