Performance of Cementless Hip Arthroplasty Stem Components by Design Type Based on Consolidated Large Registry Data

Matthew F Gong, Asher Benjamin Mirvish, Logan Finger, Alexandra S Gabrielli, Douglass Tucker[1], Johannes F Plate
[1]University of Pittsburgh Department of Orthopaedic

INTRODUCTION: Total hip arthroplasty (THA) is a successful surgical procedure that has catalyzed the development of diverse and innovative acetabular and femoral implants. Cementless femoral stem components are an area in which much innovation has been directed, and improvements have been particularly targeted at optimizing implant osseointegration while reducing failure rates through stress-shielding or wear-induced bone loss. Stem design plays a critical role in the performance of these implants, and several classification systems have been described. The most recent classification system was published in 2023 and describes six cementless stem design types and a separate system for modular stems. However, limited data exists on the usage and revision rates of different stem types to accompany this classification system. The purpose of this study was to consolidate large joint registry data for cementless hip stem components and determine overall revision rates based on stem design.

METHODS: Joint registry data on the reported overall cases and revisions for each cementless stem brand in the setting of elective primary THA was collected from the most recent annual reports of the American Joint Replacement Registry (2021), United Kingdom National Joint Registry (2021), New Zealand Joint Registry (2020), Australian Orthopaedic Association National Joint Replacement Registry (2021), and Norwegian Arthroplasty Registry (2021). Each individual stem brand was classified into a stem type derived from the classification system described by Radaelli and colleagues in the *Journal of Arthroplasty* in 2023. Stem brands with modular designs were all grouped together. Sixty-five cementless stem brands were collected from registry data with reported usage rates, revision rates, and accessible technique guides to appropriately classify the stem design. All stem brands were classified by a single fellowship-trained joint arthroplasty surgeon. Each stem type was paired individually with another stem type to compare overall revision rates utilizing a Chi-square test with alpha = 0.05.

RESULTS: Type A and type B2 stems had the highest number of existing stem brands (16 each), followed by type C1 stems (13). The most utilized stem types were 1) type B2 stems (456,923 cases), 2) type A stems (251,443), and 3) type C1 stems (139,082). The most utilized stem brands were the 1) Manufacturer 1 stem (type B2, 348,096 cases), 2) Manufacturer 2 (type A, 99,523), and 3) Manufacturer 3 (type A, 51,133). The highest overall revision rates by stem type were observed in the 1) type B1 stem (6.70%, 1,704 revisions/25,436 cases), 2) modular stem (5.88%, 571/9,715), and 3) type D stem (5.31%, 33/621). Comparatively, the lowest overall revision rates by stem type were observed in the 1) type C3 stem (1.12%, 172 revisions/15,299 cases), 2) type F stem (2.42%, 271/11,192), and 3) type B3 stem (2.55%, 48/1,880). Significant differences were observed between multiple stems, most notably with the low revision rate observed in the type C3 stem being statistically significant when individually compared to all other stem types.

DISCUSSION AND CONCLUSION: Cementless femoral stem components utilized in primary THA appear to perform well by stem design type based on consolidated large registry data. Although cumulative revision rates observed in this study were low overall, differences between stem design types were apparent which warrant further investigation. However, using registry data does not adequately substitute for studies which can more specifically examine reasons for revision and long-term survivability of specific stem brands or types. With newer stem designs being used in practice, understanding how stem types designated in current classification schemes correlate to performance is critical for comparing outcomes moving forward.