Can Hip Center Elevation be Addressed with an Offset Center of Rotation Component in Revision THA with a Jumbo Cup?

Brandon Black¹, Michael Ries, M.D.².
¹Stryker Orthopaedics, Mahwah, NJ, USA, ²UCSF, San Francisco, CA, USA.

Disclosures:
B. Black: 3A; Stryker Orthopaedics. M. Ries: 3B; Consultant of Stryker Orthopaedics.

Introduction: “Jumbo” acetabular cups are often used in successful revision total hip arthroplasty (THA) to provide a large area of bone contact and implant stability. However, jumbo cups may also result in hip center elevation and instability[1]. Eccentric liners have been used in revision surgery to improve soft tissue tensioning to account for the head center shift. However, the lateraled nature of the eccentric liners has been implicated with increased torsion and wear rate[2,3]. Alternative methods such as use of an augment or structural bone graft above a smaller cup can preserve the anatomic position of the hip center, but these represent more complex revision techniques than use of a jumbo cup. Increasing femoral head length has become the standard to address joint laxity to compensate for head center elevation with a jumbo cup in revision THA. However, this does not address the altered biomechanics associated with a high hip center. A jumbo shell with an offset center of rotation may be a more beneficial option to avoid a high hip center and reproduce normal joint biomechanics.

Methods: Previous work using a computer simulation of computer tomography (CT) scans [256 pelvic CT scans; 158 males, 107 females] identified an algorithm to model hip center change simulating a revision THA. The computer simulation demonstrated that the hip center shifted 0.27mm superiorly and 0.02mm anteriorly for every 1mm increase in reamer diameter[1]. This was accomplished by simulating a jumbo cup technique in which the inferior edge of the shell is placed at the inferior acetabular rim and the superior edge is placed against host bone at the superior margin of the posterosuperior bone defect (Fig.1) [4]. An acetabular shell with an offset center of rotation (COR) (Fig. 2), accepting standard liners, may allow for COR placement closer to the native center. The novel shell (size range Ø54-80mm) was simulated at 45º inclination/20º anteversion, and the effective vertical hip center shift was then assessed with numerical analysis. To compare the traditional “jumbo” shell to the novel shell, this study assumed a +Ø6mm minimum over ream from native acetabular diameter. This represents a relatively minimal amount of bone removal in a revision THA. The system was assessed up to a +30mm over ream to be consistent with the prior study data [4]. The vertical hip center shift, from a range of shells, was then compared to the prior study [4], to assess the net change in superior shift distance.

\[(\text{CT Study Hip Center shift}) - (\text{Novel shell COR offset}) = \Delta \text{Hip Center Shift}\]

Results: Following a simulated revision THA, Ø48-60mm native acetabulum over reamed +6mm to +18mm, representing a common “jumbo” shell technique, the novel shell design system with offset COR (Ø54-80mm), brought the COR within 2mm of the native. A traditional “jumbo” shell results in a 2.17-5.30mm hip center elevation for the same range. To characterize larger amounts of over-reaming (+20-30mm), simulating the impact of multiple revisions, or revisions to address superior gap defect, resulted in the novel shell restoring the COR within 4mm of the native acetabulum. A traditional “jumbo” shell results in a superior hip center elevation of up to 8.83mm.

Discussion: Revision THA with a jumbo cup is an effective technique to treat many acetabular bone defects. However, the use of a jumbo cup may also result in elevation of the hip center. Hip center elevation can be addressed with use of a longer femoral head or by alternative acetabular revision techniques such as an augment or structural graft above a smaller cup. Our results indicate that hip center elevation can also be addressed by “jumbo” shells with an offset center of rotation.

Significance: Hip center elevation is a clinically relevant issue that is a routine result of revision THA, and may lead to undesirable joint biomechanics. This may contribute to joint instability/dislocation, which represents the most common cause of revision THA (22.5%) [5] and can occur after a revision THA with a “jumbo” cup (10%) [6].

Acknowledgments: N/A

References: [1] Reis et. al, “Do Jumbo Cups Cause Hip Center Elevation in Revision THA?,” AAOS Scientific Exhibit-SE04
Arthroplasty, JBJS Vol. 95-A, No. 6,

ORS 2014 Annual Meeting
Poster No: 1764