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Editorial

Survival and outcomes of different head sizes in primary total hip arthroplasty

ABSTRACT

The femoral head size influences dislocation, range of motion (ROM), functional outcome, wear, and survival after total hip arthroplasty (THA). These aspects of different head sizes with contemporary bearings in primary THA have been reviewed. Based on the existing evidence, for highly-cross-linked polyethylene (HXLPE) bearings, a 32 mm cobalt chromium (CoCr) or ceramic head appears to be a suitable choice. If a 36 mm head with HXLPE is desired, a ceramic head may be preferable over CoCr due to reduced risk of fretting and corrosion with the former. For ceramic-on-ceramic (CoC) bearings, head sizes > 36 mm do not appear to provide any significant benefit over 36 mm heads. Also, large ceramic heads may lead to increased risk of squeaking. If non-cross-linked PE bearing is considered for use, it would be prudent to opt for < 32 mm head size.

1. Introduction

Total hip arthroplasty (THA) has been described as the operation of the century as it revolutionised the management of elderly patients suffering from arthritis.[1] A 22.225 mm femoral head articulating with ultra-high molecular weight polyethylene (UHMWPE) acetabular component was used in low frictional torque THA, a procedure popularised by Sir John Charnley in 1960's.[2] Over the last few decades, there has been a trend of using larger femoral heads, especially with the availability of bearings with better wear characteristics like highly-cross-linked polyethylene (HXLPE) and ceramic bearings. Large femoral heads can provide greater impingement-free hip range of motion (ROM), reduce the risk of dislocation by increasing the jump distance (JD), and are more anatomical as their size is closer to native femoral head. However, larger heads may have an increased risk of wear, resulting in loosening and failure, and mechanically assisted crevice corrosion at head-neck taper junction. These aspects are discussed in detail in the following review which focuses on the effect of femoral head size on survival and outcomes of primary THA. Metal-on-metal (MoM) THA have been excluded unless explicitly stated as they are rarely used nowadays.

2. Head size and hip ROM

Postoperative ROM after THA depends upon various factors like preoperative ROM, implant characteristics & orientation, and surgical approach. Burroughs et al.[3] assessed ROM with 28 mm, 32 mm, 38 mm, and 44 mm femoral heads using experimental hip models. They found that head size > 32 mm provided greater ROM and virtually complete elimination of component to component impingement. In a cadaveric study using five different head sizes- 22 mm, 26 mm, 28 mm, 32 mm, and 36 mm, Matsushita et al.[4] reported that hip flexion and internal rotation (IR) improved in a head size-dependent manner. The flexion and IR improved by 11.3° and 10° respectively as the head size increased from 22 mm to 36 mm. They also found that with head sizes > 26 mm, there was bony impingement of greater trochanter against the acetabulum with anterior soft tissue interposition in between. As a result of this bony impingement, the effect of head size on ROM was smaller than expected. In a clinical study, Matsushita et al.[5] reported significantly greater ROM and better activities of daily living (ADL) with 32 mm head as compared to 26 mm. Hammerburg et al.[6] reported no difference in ROM between 28/32 mm heads and 38/44 mm in 94 consecutive THAs. In a comparative study, Delay et al.[7] found no significant difference in ROM between 36 mm (CoC THA) and > 36 mm heads (40–54 mm, MoM THA). Thus, it would appear that large femoral heads (> 36 mm) did not provide any additional benefit in terms of ROM.

3. Head size and dislocation

Dislocation after THA depends upon various factors like age, gender, head size, head offset, head-neck ratio, component orientation, surgical approach, soft tissue repair, and patient factors (muscle weakness, dementia, spinopelvic balance[8–10]). JD is the amount of lateral displacement of the centre of the femoral head until subluxation. Sariali et al.[11] reported that for every 1 mm increase in head diameter, the JD increased by 0.4 mm at 45° hip abduction. Matsushita et al.[4] reported that the JD increased from 8.7° to 19.5° as head size increased from 22 mm to 36 mm. They concluded that larger head sizes resulted in delayed dislocation mainly due to increase in JD. In a clinical study comparing 28 mm and 36 mm heads, Howie et al.[12] found significantly lower dislocation rates at one year with the latter. According to the Australian Joint Replacement Registry, the incidence of dislocation at one year in ceramic-on-ceramic (CoC) bearings with ≤28 mm, 32 mm, 36/38 mm, and ≥40 mm heads was 1.8%, 0.4%, 0.3%, and 0.2% respectively.[13] Thus, it is clear that larger head size reduces the incidence of dislocation. However, the benefit offered by a large head diminishes with increase in cup inclination.[11,14] Sariali et al.[11] reported a 0.25 mm decrease in JD with every 1° increase in inclination.

Apart from the relationship between head size and dislocation, mention must be made of two other attributes related to the femoral head that can influence dislocation rates. First, the head-neck ratio, which is the ratio of diameter of the head to the diameter of the neck. A greater head-neck ratio can lead to a reduced dislocation risk by

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providing a greater arc of motion before impingement occurs. It depends upon head diameter, taper geometry, and presence of skirt on the femoral head. Thus, a larger femoral head also protects against dislocation by increasing the head-neck ratio and thus the arc before impingement occurs. Second, the head offset, which is the distance of the centre of the femoral head from the plane formed by the face of the acetabular cup. There is an inverse relationship between head offset and JD. For every mm increase in head offset, JD decreases by 0.92 mm.[11]

The effect of the type of bearing and head size on dislocation was assessed by Shah et al.[15] They looked at risk of revision for dislocation from the Australian Joint Replacement Registry data and reported no difference between metal on XLPE (MoXLPE), ceramic on XLPE (CoXLPE), and CoC bearings for 28 mm and 32 mm heads. However, 36 mm MoXLPE bearings had higher risk of revision for dislocation compared to the other two.

4. Head size and wear

Femoral head size may affect wear rates with larger heads presumably resulting in greater wear. Lachiewicz et al.[16] reported similar linear wear but greater volumetric wear of Longevity HXLPE liners with 36/40 mm heads as compared to 32 mm heads. In a retrospective review of 198 uncemented THAs using X3 HXLPE, Deckard et al.[17] reported significantly lower volumetric head penetration for 32 mm heads as compared to 36 mm. In contrast, Hammerberg et al.[6] who assessed wear rates of Durasul HXLPE found no significant difference in linear wear rates and annual or total penetration rates between 28/32 mm heads and 38/44 mm heads. Similarly, Stambough et al.[18] found no significant difference in linear and volumetric wear rates between 28 mm and 32 mm heads on HXLPE. Thus, the available literature on the effect of head size on wear appears contrasting.

5. Head size and taper corrosion

Dyrkacz et al.[19] reported greater corrosion and fretting with 36 mm head as compared to 28 mm in a retrieval study, which may be due to greater torque along the taper interface. They concluded that larger head size can generate more metallic ions into the surrounding tissues causing adverse reaction similar to MoM articulation. However, Triantafyllopoulos et al.[20] found no association between head size and degree of taper fretting and corrosion. Similarly, Cartner et al.[21] did not find any correlation between increased head size and taper corrosion.

Kocagoz et al.[22] compared material loss from the head and stem taper between matched cohorts of 50 cobalt-chromium (CoCr) and 50 ceramic head-stem pairs. They found that the total material loss from the ceramic group showed a reduction in the amount of metal released by an order of magnitude compared to the CoCr group. Similarly, Kurtz et al.[23] found lower fretting and corrosion for stems in the ceramic cohort compared to CoCr cohort. They concluded that ceramic heads may help mitigate CoCr fretting and corrosion from the head neck taper junction.

6. Head size and revision rates

In a combined analysis of six national and regional registries (Kaiser Permanente, HealthEast, the Emilia-Romagna region in Italy, the Catalan region in Spain, Norway, and Australia) which included 14,372 MoHXLPE THAs, Allepuz et al.[24] (JBJS Am 2014) reported no significant difference in risk of revision between 32 mm and smaller or larger heads.

Data from the National Joint Registry[25] showed that for metal-on-polyethylene (MoP) cemented monobloc cups, 32 mm heads had worse failure rates as compared to < 32 mm heads. Forty-four mm head size showed the worst failure rates for MoP bearings with uncemented shell and polyethylene (PE) liner. For ceramic-on-polyethylene (CoP) cemented monobloc cups, 36 mm heads had the worst failure rates whereas, the 32 mm head sizes showed the lowest revision rates overall. For CoP with metal shells and polyethylene liners, the best survival was with 32 mm heads. The registry data however, did not differentiate between cross-linked and non-cross-linked PE. For uncemented CoC THA, 28 mm, 32 mm, and 36 mm heads showed similar failure rates which were worse than 40 mm heads.

Data from the Australian Joint Replacement Registry[13] suggests that the rate of revision increases with larger head sizes for non-cross-linked PE bearings; the lowest being for < 32 mm head size. For XLPE bearings, 32 mm head size had the lowest rate of revision. There was no difference between head size < 32 mm and > 32 mm. There was no difference in rate of revision between MoXLPE and CoXLPE bearings. For CoC bearings, head sizes 36–38 mm, and ≥ 40 mm had a lower rate of revision compared to 32 mm heads. There was no difference in rate of revision between ≤ 28 mm and 32 mm heads and between 36 and 38 mm and ≥ 40 mm heads. The above data pertain to THA for osteoarthritis.

7. Conclusions

The selection of head size during THA depends upon the size of the acetabular component. A minimum liner thickness of 6 mm is generally recommended, irrespective of the bearing type.[26] Based on the current evidence, for HXLPE bearings, a 32 mm CoCr or ceramic head appears to provide a good balance with benefits of greater stability compared to < 32 mm heads and lower revision rates compared to < 32 and > 32 mm heads. If a 36 mm head with HXLPE is desired, a ceramic head may be preferable over CoCr due to reduced risk of fretting and corrosion with the former. For CoC bearings, head sizes > 36 mm do not appear to provide any significant benefit over 36 mm heads. Also, large ceramic heads may increase the risk of squeaking.[27,28] XLPE bearings have a lower revision rate as compared to non-cross-linked PE after 3 months.[13] If non-cross-linked PE bearing is considered for use, it would be prudent to opt for < 32 mm head size. Finally, in addition to head size, other factors like restoration of hip biomechanics (hip centre, offset, leg length), soft tissue tension, and implant orientation also play a crucial role for a successful outcome after THA.

Declaration of competing interest

None.

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