6.4 Trend: Bigger Ball Heads: Is Bigger Really Better?

K.-H. Widmer

Size matters! This is not only true in most parts of today's life but also in total hip arthroplasty in recent years. The head size of the femoral prosthesis has been increased over the years up to the normal femoral head size. But the question arises whether total hip arthroplasty will meet the same fate as the dinosaurs in former times since size seems not to be the only parameter that is important. Looking at the short history of total hip arthroplasty there was a trend to smaller head sizes which was inaugurated by Sir John Charnley in the sixties. He introduced the low friction arthroplasty which is characterized by a smaller head diameter and high density polyethylene as the articulating surface of the cup demonstrating lower friction characteristics. Such, he was able to gradually replace the metal-on-metal arthroplasty of that time. In the latter large head diameters have been used and unfortunately these arthroplasties suffered from friction problems because of unresolved clearance incompatibilties.

Besides low friction smaller heads demonstrated another very important advantage: a lower rate of debris was observed with smaller heads. Since time did show that debris does play a major role in the aseptic loosening process of a total hip arthroplasty using small head size has become a kind of paradigm in total hip arthroplasty, at least for components made out of polyethylene. Small head sizes exert a smaller sliding distance on the articulating surface thus reducing the machining effect of any surface roughness. This is probably the main cause for the reduced debris in smaller heads.

But smaller head sizes did not show favorable effects only but also detrimental ones. Smaller prosthetic head sizes are linked to a higher rate of prosthesis dislocations [1,4,7] whereas larger heads did show a higher resistance against dislocation [2,3]. Since dislocation is still a major concern in total hip arthroplasty any mean to reduce the dislocation rate is an attractive option per se. In former times gaining higher resistance against dislocation by using larger head sizes had to be trade-off against the higher rate of debris associated with larger heads. With the advent of hard-on-hard bearing like ceramic-on-ceramic and metal-on-metal large diameter heads have become applicable without additional draw-backs and therefore the use of larger diameters has become more popular. The rate of dislocation could be reduced dramatically by this mean in accordance with former clinical experience. As soon as highly cross-linked polyethylene has become available the use of large diameter head has become even more popular [5], a real boom has started. One has to point out that by using larger diameter heads articulating against cross-linked polyethylene a remarkable part of the gain in debris reduction is lost again. So, in arthroplasties with polyethylene there is still this trade-off between stability and debris.

Larger head sizes have also become popular because of the increased range of motion. The risk for prosthetic impingement is reduced when a higher head to neck ratio is achieved. This reduces the risk for damage at the rim of the cup and at the prosthetic neck [6]. The rate for dislocation due to neck-to-cup impingement is reduced too resulting in a more stable total hip arthroplasty.

Larger heads increase the stability of a total hip not only by reducing the risk for impingement but also by increasing the distance the head has to be lifted out of the cup when the patient sustains such an undesirable event. The higher the distance the higher the resisting force exerted by the surrounding soft-tissue. This force is counteracting against dislocation forces. Larger heads in total hip resurfacing arthroplasties achieve the same increase in joint stability as large heads in a standard type of a total hip arthroplasty. It should be noted that in hip resurfacing the use of larger heads does not necessarily increase the range of motion since the head-to-neck ratio is decessive for a good range of motion not the pure diameter alone.

What are the downsides of large diameter heads? Well, increasing the head size does increase the range of motion, but the gain in increase becomes smaller and smaller at larger diameters. So, stepping from a 22mm head to a 32mm head is more beneficial than stepping from a 32mm head to a 42mm head.

Furthermore, there is a leveling-off at a certain head-to-neck ratio since the range of motion is not limited by prosthetic impingement alone but also by bone-to-bone impingement, i.e. from a specific head-to-neck ratio on the impingement that limits the range of motion switches from prosthetic to bone-to-bone impingement. In other words, increasing the head size is not reflected by an increase in range of motion any more in larger heads and hence increasing the head diameter is not beneficial any more and therefore is not needed.

Additionally, larger head diameters limit the wall thickness of the acetabular socket, especially of the acetabular liner in modular implants. Decreasing the wall thickness in these implants may put both type of components, those made out of polyethylene and ceramic, at risk for breakage or exessive deformation.

Larger head diameters pose an additional task when reducing the hip during surgery since a larger distance is needed for reduction. This might be overcome by exerting higher pulling forces, but one has to consider that higher forces may also act during slippage of the head over the rim of the cup. In hard-on-hard bearings this edge loading may lead to surface damage putting the arthroplasty at an additional risk.

After all, larger diameter heads do show a couple of advantages in the clinical setting but the benefits are becoming smaller and smaller in the upper diameter range. Therefore, there exists a reasonable limit for the upper head diameter. Time and clinical experience has to tell where this limit has to be placed. There is increasing evidence that a maximum 44mm diameter head turns out to be a good compromise with respect to joint stability and range of motion. In any case, minimal wall thicknesses will dictate the maximum head diameter especially in smaller sized hips like in women or in the asian population. In these cases smaller heads than 44mm have to be accepted.

References

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