

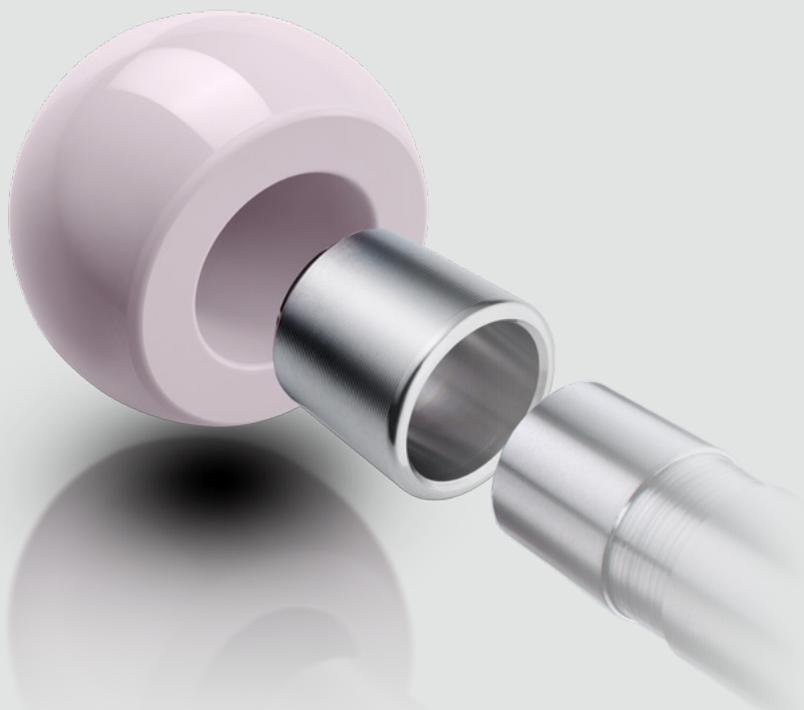
## Sleeved Ceramic Heads: Versatile, Essential and Proven

Sleeved femoral heads made of BIOLOX®*delta* ceramic were introduced in 2005 with the brand name BIOLOX®*OPTION*. They offer the possibility of adjusting offset intraoperatively, but also revising a femoral head implant while retaining a well-fixed femoral stem with minor damages on the taper surface. The adapter sleeve was designed to create a pristine taper interface for the ceramic head before it is placed on a stem which remains *in situ*. Recent publications offer additional evidence on the protecting role of the sleeve.

### Restoring the interface

In hip revision, the metal taper of an otherwise intact and well-fixed stem can exhibit varying types of damage: scratches, scars, flattened or burnished areas which may be attributed to assembly or disassembly damage as well as black debris indicating fretting or even corrosion<sup>1</sup>. Depending on the grade of the taper damage, the use of a sleeved ceramic head can offer a possibility to retain a well-fixed stem.

The surface of a metal taper is manufactured with a special structure for optimal stress distribution. The adapter sleeve is intended to restore a pristine interface on its outer and to compensate slight damages on its inner side, to enable a secure head-taper lock and to avoid rotation of the new ceramic head.





## Recent findings with BIOLOX®OPTION

**Chaudhary et al.**<sup>2</sup> from the Massachusetts General Hospital in Boston investigated the pull-off strength and seating displacement of BIOLOX®*delta* femoral heads and titanium taper sleeves. Two head diameters and two sleeve offset lengths were mated with trunnions at two different impaction forces. The sleeved heads showed a fixation strength similar to values published for non-sleeved heads. The pull-off force increased linearly with the assembly force as well. The head diameter did not have a significant effect on the measured parameters. Compared to short offset length, extra-long sleeves showed lower pull-off forces, particularly at higher impact forces. The authors confirmed that this may potentially result in better clinical outcomes by mitigating fretting corrosion.

Prof. Morlock's research group at the **Technical University of Hamburg (TUHH)** investigated the impact of stem taper damage on the fracture strength of sleeved ceramic heads. For this purpose, **Dickinson et al.**<sup>3</sup> compared the fracture resistance of sleeved BIOLOX®*delta* heads while **Falkenberg et al.**<sup>4</sup> simulated the fracture resistance of sleeved heads and compared them with non-sleeved BIOLOX®*delta* heads after impaction on severely damaged tapers.<sup>4</sup> Four categories of severe taper damage were reproduced:

- a. Truncated
- b. Slanted
- c. Crushed
- d. Scratched

**NOTE:** With an already used stem taper, the surgeon has to make sure that the form of the taper remains unchanged and inspect it for damages such as severe abrasion/material loss, elevations and/or deep scratches ...

The categories of deformation reproduced at the TUHH are considered by manufacturers as unacceptable. Therefore, the use of sleeved BIOLOX®*delta* heads on such tapers is not allowed.

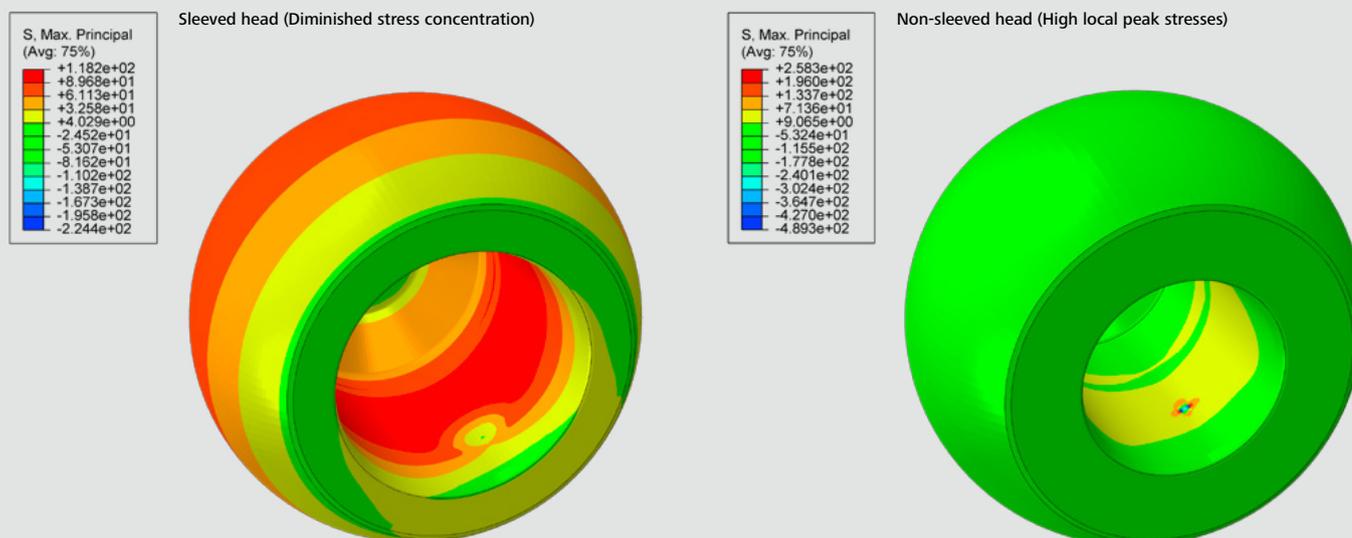
In both studies, the fracture strength of sleeved BIOLOX®*delta* heads measured with all investigated stem taper damage types was several times higher than the fracture force required by FDA recommendations. The heads were subjected to the ISO 7206-10 standard ultimate compression test, which is far from physiological loadings. The fixation strength of the taper junction depends on multiple factors which may vary in the clinical setting such as head diameter, assembly force and the angle, length and surface roughness of the taper. All these factors may influence the stress distribution and other conditions as the contamination junction<sup>5</sup>.

## Uncompromised taper shape required

The unpredictability of these factors supports the manufacturer guidelines, which do not allow the implantation of sleeved heads in the extreme conditions tested in this study. Therefore, the surgeon must make sure that the shape of the taper is not compromised due to damage, such as severe wash-out areas, severe abrasion, material loss, deep scratches and ridges or similar defects.

The numerical simulations<sup>4</sup> showed comparable fracture forces for truncated, slanted and crushed tapers for both sleeved and non-sleeved heads. However, the investigation showed that small local metal elevations at the edge of a scratch or at a surface damage can lead to early failure of non-sleeved ceramic heads despite their high fracture strength. Indeed, high local stress peaks generated by a small metal elevation ("scratch") drastically reduced the fracture strength of non-sleeved heads (-96%), whereas sleeved heads remained unaffected.

*The adapter sleeve compensates the punctual stresses caused by metal elevation of the retained stem taper and optimizes the stress distribution.\**



\* Courtesy of Professor M. M. Morlock, TUHH



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