Selection of a bearing couple in cases of revision after a fractured ceramic component

The hard on soft articulation material options ceramic/polyethylene (PE), ceramic/crosslinked polyethylene (XPE) and metal (CoCrMo)/XPE were tested in order to evaluate the possible effects of ceramic particles on the wear behaviour (third body wear) of each of these options.11

Materials and methods

Ball heads: aluminium oxide matrix composite (BIOLOX®delta), CoCrMo
Inserts: Highly crosslinked UHMWPE 32mm, UHMWPE 32mm
Ceramic third body particles: aluminium oxide ceramic particles (BIOLOX®forte)

Ceramic third body particles were inserted in the articulation in order to evaluate the effect of the wear condition on the wear behaviour of each of the articulation options (Figs. 1–2).

The different articulation options, BIOLOX®delta and CoCrMo ball heads in combination with PE and XPE inserts, were tested utilizing a hip joint simulator (EndoLab® Rosenheim). Ceramic particles were inserted into the PE or XPE inserts in specific points corresponding to the main load transfer area before the start of the test (Fig. 2). During the test, additional ceramic particles were introduced into the articulation area as part of the test fluid (calf serum) used in the simulator test chambers (Fig. 1). All of the articulation material combinations were tested up to 5 million cycles.

The tests were carried out according to the ISO 14242 Part 1 and 2 standards. Damage to the surfaces of the articulation material combinations was assessed visually. The resulting wear was gravimetrically measured.

Results

Ceramic/PE and ceramic/XPE

The test results with the addition of the third body ceramic particles show that the articulation material options, ceramic/PE and ceramic/XPE may represent a viable treatment option after the fracture of a ceramic component. The use of a ceramic ball head in these cases minimizes volumetric wear and related wear complications caused by third body wear. The volumetric wear in the Co/XPE articulation material combination was less by a factor of 1000 than that created by the Me/XPE combination (Fig. 6). It was not possible to quantify the volumetric wear of the PE and XPE inserts because of the effect of the ceramic foreign particles that had been inserted into their surface. Visual observation of the PE and XPE insert surfaces found them to be still functional even after 5 million cycles (Figs. 3–4).

Conclusion

1. Of the bearing couples tested so far, ceramic/ceramic bearing couples had a very low wear volume. (Fig. 5)6. From a tribological viewpoint, the ceramic/ceramic articulation material option represents the best treatment option after a ceramic fracture.8

2. The second best treatment option from a tribological viewpoint was found to be the ceramic/PE articulation material option.

3. Based on the results of our testing, the use of the metal/PE articulation material option after a ceramic fracture is contra-indicated.1–5, 11-20 Ceramic particles can be lodged into the PE insert articulating surface, resulting in severe destruction of the metal ball head. (Figs. 7–8)

Clinical experiences confirm the test results.6, 7, 10–12 BIOLOX®OPTION ball heads made of BIOLOX® delta material are available for treatment after a ceramic fracture.

References