**EVALUATION OF PEEK FOR SHOULDER ENDOPROSTHETICS IN A SCREENING AND A SIMULATED PHYSIOLOGICAL WEAR TEST**

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**Introduction**

The Mathys shoulder hemiprostheses made of POM-C (Polyoxymethylene) have been successfully implanted for years. This biocompatible thermoplastic polymer exhibits high strength, rigidity and in addition a high resistance against solvents and disinfectants. In the last years, the polymer PEEK (Polyetheretherketone) has been more and more used for manufacturing synthetic medical implants. Its characteristics are the very good mechanical properties, the high resistance to chemicals, wear and γ- irradiation.

The aim of this study was to compare the wear behavior of the two polymers when articulating with bovine cartilage in view of a possible replacement of POM-C by PEEK in shoulder prostheses. Therefore, two in vitro tests were performed, a pin-on-disc test and a more physiological investigation.

**Materials and Methods**

For screening a pin-on-disc test was carried out on the OrthoPOD wear testing machine (AMTI Watertown, USA). POM-C (n=6) and PEEK (n=6) pins of a diameter of 9.5mm, a length of 20mm and a tip radius of 22mm were moved over cartilage specimens. Therefore, bovine discs with a diameter of 40mm were retrieved from the patella and immersed in a 30% serum solution were taken. Thanks to pneumatic regulation, the pins were able to follow the established rectangular path (5mmx3mm) on predefined load conditions even if the surface of the cartilage discs was not perfectly flat. The applied load was changed from 0.2MPa to 0.4MPa in each single cycle (Fig.1).

**Figure 1:** Wear path and applied load pattern for pin-on-disc test.

The number of cycles was 200’000 with a frequency of 1Hz. The weight change measured after conditioning before and after the tests was used to establish the volumetric wear of POM-C and PEEK pins and the weight loss of the bovine discs.

The second wear test consisted in a physiological test of the Mathys 44mm shoulder hemiprosthesis made of POM-C (n=2) and PEEK (n=3). Bovine cartilage discs taken from the acetabulum were used as gliding partners. During testing, the discs (20mm dia.) were fully immersed in a 0.9% NaCl solution, whereas the shoulder prosthesis was immersed only partially.

**Figure 2:** Pin-on-disc test set-up Right) Physiological shoulder test set-up.

The testing machine simulated a swinging phase of 90° and axial rotation of 30° forward and backward during one single cycle (Fig.2). The number of cycles was again 200’000 at a frequency of 1Hz. A constant load of 200N in the axis of the shoulder prosthesis was applied to the prosthesis-disc system. In order to somewhat relieve the cartilage, the testing machine was only functioning 12 hours a day and staying in unloaded rest for the other 12 hours. The difference in weight before and after the test allowed to establish the volumetric wear of the hemiprostheses.

In order to establish the absolute loss of weight, the swelling amount of POM-C and PEEK pins and hemiprostheses was measured and taken into consideration in both tests.

**Results**

The two following diagrams show the volumetric wear of the tested implants:

**Figure 3:** Volumetric wear of PEEK and POM-C on bovine cartilage. Left) Pin-on-disc test Right) Physiological test set-up.

A different behavior between the two materials could be observed with regard to the wear rate of the tested samples.

In the pin-on-disc test, the mean wear volume of POM-C and PEEK pins after 200’000 cycles was 1.85±0.52mm³ and 0.32±0.42mm³ respectively. The PEEK material presented a wear factor amounting to 17% of that of POM-C.

In the physiological test, the mean wear volume of POM-C and PEEK shoulder hemiprostheses after 200’000 cycles was 10.02±2.14mm³ and 1.64±5.94mm³ respectively. The PEEK material presented a wear factor amounting to 16% of that of POM-C.

**Discussion**

The swelling factors of both materials play a very important role when determining the absolute wear behavior of the tested components. These factors, provided by the weight difference of the reference bodies fully immersed in serum (pin-on-disc test) and partially immersed in Ringer solution (physiological test) for a defined testing time, depended on the way of weighing these bodies requiring a strict protocol. Before the test, the pins and shoulder prostheses were washed with alcohol and placed in a desiccator for at least 4 hours in a relative atmospheric humidity of 50%. After the tests, the following operations were carried out prior weighing in order to eliminate salt crystals and proteins from the different components: ultrasonic bathing in deionized water for 10 minutes, re-washing the surface with deionized water, replacing them in the desiccator for 1 hour. The precision of the balance was of 10mg for the pins and 10mg for the shoulder prostheses. The swelling factors of POM-C and PEEK were respectively: 0.4% vs. 0.1% (pin-on-disc test) for pins and 0.058% vs. 0.024% (physiological test) for shoulder prostheses respectively.

**Conclusion**

The tests showed the higher wear resistance of PEEK on bovine cartilage in comparison with POM-C. As PEEK has also good mechanical properties, high chemical resistance and favorable irradiation resistance, it is probable that this material will be used for manufacture of future shoulder hemiprostheses. Further studies are in progress to evaluate optimal slide pairing for total shoulder arthroplasty.

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**Poster Session - Shoulder and Elbow - Hall E**