Combined mechanical and corrosion failure mechanism of a tumoral reconstruction hip prosthesis: a case report with SEM evaluation

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INTRODUCTION: Metallic biomaterials used for total hip replacement surgery are subject to different corrosion and wear mechanisms. The aim of this study is to evaluate the failure causes from the biomechanical and the biomaterials point of view, and study metallurgical changes of some taper junctions of in-vivo loaded modular stems. Modularity is being diversified in total hip prostheses to ameliorate the surgical technique, to optimize implant fixation and adjust hip biomechanics; new reconstructive and minimally invasive techniques require special modular design.

METHODS: One customised implant (DLS®Stryker hip revision stem combined with a retrograde nail for an osteosarcoma resection-reconstruction in a 17 years old patient) was investigated after retrieval following 3 years of in-vivo use. All contact surfaces of the modular elements were assessed by scanning electron microscopy.

Fig.1: Image of the retrieved customised prosthesis

RESULTS: The retrieved implant showed cracks and a large amount of measured debris; failure patterns were present at the connection area between the two implants. The artisanal morse-type taper junctions failed mechanically, even if corrosion and wear affected all tapers.

Fig.2: Failure zone - macroscopic aspects

Surface analysis and laboratory investigations of previous retrieved hip prosthesis components have proven that the morse taper junctions of the stem are stable and resistant to relevant wear mechanisms. At the connection, the surface displayed typical fatigue fracture patterns; the cause was poor machining with a fatigue crack that yielded to overstress failure under cyclic loading. Periprosthetic bone loss was minimal probably due to short service life of the implant.

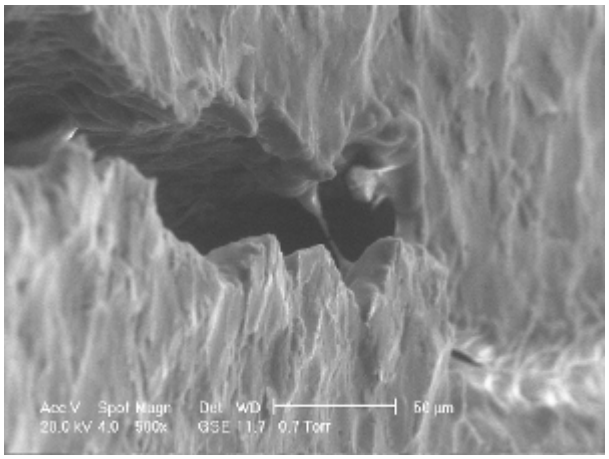

Fig.3: Scanning electron micrographs of the same failure zone (dimpled fractures, a feature of overstress failure)..

DISCUSSION & CONCLUSIONS: If an original taper design is selected, the advantages of modular femoral components in total hip arthroplasty will outweigh the possible risks. Artisanal mechanisms and combinations between implants from different sources are prone to rapid failure due to high mechanical stress and metallic biomaterials with different strenght characteristics. Tumoral reconstruction surgery may require custom made implants, frequently unavailable or too expensive for the current clinical use.

REFERENCES: Pohler OEM failure of metallic orthopedic implants. In Metal Handbook vol 11, Failure Ananlysis and Prevention, 9th Edition Metals Park, OH, ASM, 1987: 670-694