Interface membrane fibroblasts around aseptically loosened endoprostheses express MMP-13

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Introduction: Aseptic loosening of endoprostheses is the major cause of their failure. Loosening occurs due to a variety of factors, among them the development of a synovia-like interface tissue between prosthesis and bone, causing a weakening of the material – bone bonding. In this interface tissue, high levels of Matrix metalloproteinase-13 (MMP-13) have been found. As MMP’s are expected to cause tissue degradation and thus contribute to prosthetic loosening, we were interested in the nature of the cell releasing MMP-13.

In spite of much work, the cell population producing human MMP-13 in aseptic implant loosening has not yet been identified. Therefore, in the present study we examined periprosthetic interface tissues with the aim of characterizing and identifying the cell types which express MMP-13. For this purpose, interface membranes from loosened endoprostheses were compared to synovial tissues from osteoarthritic individuals and from young patients with mild joint deformity. We describe fibroblasts as a new cell type expressing MMP-13 during aseptic loosening of total joint replacement implants. MMP-13 has a high collagenolytic activity and therefore may play a critical role in the degradation of the peri-implant bone.

Materials and Methods: Tissue specimens were collected from the bone-prosthesis interface at the time of revision surgery of clinically loosened hip and knee arthroplasties (n=27). Synovial tissues from osteoarthritic patients and young patients with mild joint deformity were used as controls (n=6). Tissue samples were fixed in 4% PFA, decalcified with EDTA and embedded in paraffin. 4 mm sections were stained with haematoxylin/eosin and for the osteoclastic marker enzyme tartrate resistant acid phosphatase. Monocytes/macrophages were characterized with a monoclonal antibody against CD68 and mRNAs encoding MMP-13 and a1collagen I (COL1A1) were detected by in situ hybridization.

Results: Cells expressing transcripts encoding MMP-13 were found in 70% of the interface tissues. These cells co-localized with a cell population expressing COL1A1 mRNA, and were fibroblastic in appearance. MMP-13 expressing cells were found in the close vicinity of osteoclasts and multinuclear giant cells. These cells were localized in the interstitial tissue surrounding the multinuclear cells and in resorption areas close to the multinuclear cells. Around polyethylene material many MMP-13 positive cells were found closely adjacent to the polyethylene particles No signals for transcripts encoding MMP-13 were detected in multinuclear giant cells or in osteoclasts. Control tissues were negative for transcripts encoding MMP-13 mRNA.

Discussion: Fibroblasts of the interface from aseptically loosened endoprostheses selectively express MMP-13. By the expression and the release of MMP-13, these fibroblastic cells may contribute to the local degradation of the extracellular matrix and to bone resorption. We assume that implant particles may initiate the release of MMP-13 and subsequent osteolysis. Fibroblasts, expressing MMP-13 were found to be localized around osteoclasts and multinucleated giant cells. It is suggested that MMP-13 synthesized by periesteoclastic cells plays a role in bone matrix collagenolysis through osteoclasts. This also suggests that osteolysis is closely connected with MMP activity and that MMPs might be a therapeutic target to prevent osteolytic bone destruction. The cellular source concerning MMP induced osteolysis needs to be further examined.