INTRODUCTION: Stress shielding induced bone resorption is now a well established and recognized phenomenon seen in medium to long term periprosthetic bone remodelling. Analysis of the periprosthetic bone remodelling process on serial radiographs is valuable on a clinical level but with standard deviations >25% it is too crude for many quantitative studies. Dual energy x-ray absorptiometry (DEXA) is more accurate and can quantitate periprosthetic bone density changes with ca. 5% error but only if the regions of interest have a certain minimum size. This size is too large to study bone remodelling effects in small but critical areas such as different regions adjacent to the coated part of an implant. Coating resorption cannot be studies by DEXA at all and therefore only a few articles have been published on the hydroxyapatite (HA) resorption of coated hip implants in vivo. In this study bone ongrowth and HA residue were measured histomorphometrically on hip stems of one single design retrieved post mortem.

MATERIALS AND METHODS: 13 patients out of a prospectively followed series of over 1000 consecutive primary ABG-I (Stryker) total hip arthroplasties gave written consent for retrieval of their operated hip post-mortem. All 13 patients (10 female, 3 male, age: 58-86 years) had unveventful THA procedures and died from causes unrelated to hip diseases. The time from implantation (stem in-vivo) ranged between 3.3 to 11.2 years. The femoral stems were made of titanium alloy (Ti6Al4V) with the proximal third HA-coated by plasma-spray onto a macro-relief surface. The coating had a HA content of more than 90% with a porosity of less than 10%. Crystallinity was 100% before coating and more than 75% thereafter. The grain size was 20-50 micron, and the strength of the tensile bond was 62-65 MPa. The thickness of the hydroxyapatite layer was 60±15 micron.

Specimen Preparation: The prostheses and surrounding bone were collected post-mortem, immersed in buffered formalin for seven days and then dehydrated for 24h in 70% ethanol. Three cross sections were cut from the metaphyseal femur proximal to a line separating the proximal Gruen zones 1 and 7 (regions with HA coating) from the distal stem (Fig. 1). The three sections were A (proximal), B (mid-part) and C (distal).

Each segment was embedded in a PMMA resin. Five 20 micron sections were cut from each segment (Donath technique). The sections were stained (paraflon staining, a combination of basic fuchsin and toluidine blue) for qualitative histology and quantitative histomorphometry.

Specimen Analysis: A Polyvar microscope (Reichert-Jung, Austria) was used for qualitative analysis and quantitative analysis was performed on an Axioskop microscope (Carl Zeiss, Germany) equipped with a colour image analysing system (SAMBA; Technology, France). Implant, bone, and lacunae including all soft tissues were successively identified. For each segment the total implant perimeter, the percentage of implant perimeter covered by bone and the total percentage of residual HA coating were measured. Bone implant contact was defined as direct ongrowth of bone to the HA coating or to the titanium surface after HA resorption and represented the amount of osteointegration. The percentages of bone ongrowth and of residual HA coating were compared between the three section levels and were correlated to the total time in-vivo and the patient age. Statistical analysis used the Spearman test for correlations and the paired student t-test for comparisons (significance at p<0.05). The pathologist was blinded to the any clinical information.

RESULTS: HA resorption increased significantly with the time in-vivo as measured by the residual HA (e.g. <6yrs: Avg.=36.7%, >6yrs: Avg.=10.1%, p=0.02). This correlation was true for all sections A, B and C (p=0.02-0.03). Beyond 8 years HA was almost gone. (Fig. 1).

Bone ongrowth ranged between 18%-56% and was statistically independent of the time in-vivo (Fig. 2). Bone ongrowth was most strongly correlated to patient age with younger patients having significantly higher bone ongrowth than older patients (p<0.001, Fig. 3).

DISCUSSION: A Polyvar microscope (Reichert-Jung, Austria) was used for qualitative analysis and quantitative analysis was performed on an Axioskop microscope (Carl Zeiss, Germany) equipped with a colour image analysing system (SAMBA; Technology, France). Implant, bone, and lacunae including all soft tissues were successively identified. For each segment the total implant perimeter, the percentage of implant perimeter covered by bone and the total percentage of residual HA coating were measured. Bone implant contact was defined as direct ongrowth of bone to the HA coating or to the titanium surface after HA resorption and represented the amount of osteointegration. The percentages of bone ongrowth and of residual HA coating were compared between the three section levels and were correlated to the total time in-vivo and the patient age. Statistical analysis used the Spearman test for correlations and the paired student t-test for comparisons (significance at p<0.05). The pathologist was blinded to the any clinical information.

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