Histopathological study of the implant-bone interphase in patients with TWA

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Background

In the literature, osteolysis or radiolucency with or without prosthetic loosening after total wrist arthroplasty (TWA) have frequently been reported \(^1\)\(^{-6}\). Similar findings have been reported in other joints \(^7\). Polyethylene wear has been accepted as a major cause of osteolysis in total hip arthroplasty (THA) \(^8\)\(^{-10}\). Metallic debris has also been cited to be an underlying cause and abnormal Cr- and Co-levels in blood can be found in patients with metal-on-metal THA \(^11\)\(^{-14}\).

Material and methods

We report on a consecutive series of TWA with the Remotion implant, in which samples were harvested from the periprosthetic area in view of histopathological examination and bacteriological culture. The blood level of Cr and Co in these patients was also investigated, as well as the WBC and level of CRP. The Scientific Ethical Committee of the Capital Region of Denmark approved the study. We aimed at correlating the findings with the width of periprosthetic zones with radiolucency, measured at selected spots on serial annual PA-radiographs (figure 1).
Figure 1: Spots for measuring the width of periprosthetic radiolucent zones.

13 patients operated at Gentofte Hospital between 2003 and 2009 were elected for the study, after exclusion of:

1. Wrists that had been revised to a new TWA or fusion;
2. Patients that were unable to participate due to geographical reasons;
3. Patients who had not given informed consent;
4. Patients with conditions that contraindicated the surgical procedure.
Main Findings

Demographics

Diagnosis was rheumatoid arthritis in 6 patients, idiopathic osteoarthritis in 4 and posttraumatic osteoarthritis in 3. Mean age was 68.8 (53-87) years. The mean follow-up period was 6.2 (3-10) years.

Radiology

Progressive radiolucency was seen in 7 patients at spot 4-5. In 3 of these patients its width remained less than 1 mm (average width of zone 4 and 5). In 3 patients it increased to between 3 and 4 mm and stabilized. In 1 patient with idiopathic wrist osteoarthritis, it increased rapidly and impressively but seemed to stabilize between 8 and 9 mm after 4 years without loosening of the implant (assessed by serial radiographs and CT-scans with the Philips O-MAR software, figure 2 and 3). In the remaining 6 patients there was no radiolucency at all at the radial component.

Figure 2: rapid progression of periprosthetic osteolysis after TWA in a patient with osteoarthritis.
At spots 9-10 progressive radiolucency was seen in 7 patients. In 3 of these its width remained less than 1 mm (average width of zone 9 and 10). In 3 patients it increased to between 3 and 4 mm. In 1 patient it increased to 5 mm. There is no complete overlap of the patients with this pattern at spots 9-10 and the patients with the similar pattern at spots 4-5: progressive radiolucency was present in a total of 8 patients, 2 patients having radiolucency at either spots 4-5 or spots 9-10, 6 patients having radiolucency in both areas. We did not see radiolucency at spots 1-3 and only a minimal radiolucency in 2 patients at spots 6-8 (0.33 and 0.4 mm resp.).

There was no evidence of radial implant loosening in any patient. In 3 patients subsidence of the carpal component was evident, 2 of these patients having periprosthetic radiolucency under the carpal plate.

**Histopathology**

24 specimens were obtained: 13 harvested from the dorsal aspect of the area between the radial component and the radius itself, 10 harvested from the dorsal aspect of the area
between the carpal component and the carpus itself, 1 from the area adjacent to a metallic ulnar head implant (SBI).

Foreign body material was seen in 22 specimens: metal particles in 19, polyethylene fragments in 12. Bone cement fragments were not seen (only 2 implants were cemented).

The presence of metal particles in the proximal specimens (i.e. at the radial component), semi quantitatively assessed, correlated very poorly with the width of radiolucency at spots 4-5 (Spearman rho 0.243, scatter plot in figure 4), and their presence in the distal specimens (i.e. at the carpal component) was not correlated to the width of radiolucency at spots 9-10 (Spearman rho -0.082) (zones 1-3 and 6-8 being not relevant).

The presence of polyethylene in the proximal samples correlated negatively with the width of radiolucency at spots 4-5 (Spearman rho -0.175, scatter plot in figure 5). The same applied to polyethylene in the distal samples and the radiolucent zone at spots 9-10 (Spearman rho -0.255).
Figure 4. Scatter plot showing the correlation between the occurrence of metallic particles and the width of radiolucency at spots 4-5.
Figure 5. Scatter plot showing the correlation between the occurrence of polyethylene fragments and the width of radiolucency at spots 9-10

There was no histopathological evidence of infectious or rheumatoid activity (no polymorphonuclear leukocytes, no granuloma, no lymphoid follicles with Allison-Ghormley bodies, no plasma cells with Russell bodies, no synovial Grimley-Sokoloff giant cells).

In the patient with the most pronounced development of radiolucency, there were no polyethylene particles to be detected in the samples at all and only very few metallic particles.

**Blood analyses**

Mean blood level of Co was 0.253 µg/L (SD 0.275), mean blood level of Cr 0.264 µg/L (SD
There was no correlation between the blood level of Cr and the width of the radiolucent zones at spots 4-5 and 9-10 (zones 1-3 and 6-8 not relevant), and a reversed weak or moderate correlation for the blood level of Co. There were no serological indications of ongoing infection.

**Bacteriology**

All cultures were negative.

**Conclusions and interpretation**

We found no evidence that indicated a correlation between the presence of metal or polyethylene debris in the periprosthetic area adjacent to the wrist joint and the development of periprosthetic radiolucency after TWA with the Remotion implant. Thus polyethylene wear or the presence of metallic debris seems not to be a major factor in the development of periprosthetic radiolucency after TWA. Neither seems rheumatoid or infectious activity to be a factor. Until further notice, we therefore consider *per exclusionem* that the most likely cause is bone resorption due to stress shielding.


9. Orishimo KF, Claus AM, Sychterz CJ, Engh CA. Relationship between polyethylene wear and osteolysis in hips with a second-generation porous-coated cementless cup after


