INTRODUCTION

Several studies have shown elevated levels of metal ions in blood of patients with metal-on-metal (MM) total hip arthroplasty (THA). Hip resurfacing is a new alternative for young patients requiring a hip replacement. The in vivo release of ions from these surfaces is however not well known. An important purpose of the present study was to compare the concentrations of metal ions in blood of patients with hip resurfacing and MM THA.

The outstanding question that remains is the clinical impact of these elevated ion levels. Even though concerns about chromosome aberrations, changes in peripheral blood lymphocytes, and the risk of cancer were continuously raised in the literature, there is no conclusive evidence that the elevated levels of cobalt (Co) and chromium (Cr) have any detrimental effects on the patients. It is known that Co and Cr ions undergo redox cycling that result in enhanced production of reactive oxygen species. This can lead to irreversible biochemical changes to lipids, proteins, and DNA with subsequent cell and tissue damages. However, the potential of metal ions released from MM implants for oxidative stress damages is unknown. In the present study, we also measured the concentrations of three oxidative stress markers in blood of patients with hip implants.

MATERIALS AND METHODS

Blood was collected 6 months and 1 year after implantation time into Sarstedt Monovette® tubes for trace metal analysis from 66 patients with articular surface replacement (ASR®, DePuy Orthopaedics), 23 patients with 28 mm-head MM THA, 54 patients with 36 mm-head MM THA, and 18 patients with metal-polyethylene (MePe) THA. The concentrations of Co and Cr were analyzed by inductively coupled plasma-mass spectroscopy. Statistical analysis was performed using the Mann-Whitney U test. P<0.05 was considered significant.

Total antioxidant levels were measured by the Oxford Biomedical total antioxidant power assay (Oxford, MI) to obtain an overview of the defense capacity of patients against oxidative stress. Peroxide concentrations were measured by the Biomedica OxyStat assay (Medicorp, Montreal, QC) to quantify damages to lipids in the systemic circulation. Nitrotyrosine levels were quantified using the BIOXYTECH® Nitrotyrosine-EIA assay (OxisResearch™, Portland OR) to measure damages to proteins.

RESULTS

Figure 1 shows that after 0.5 year, the median Co levels increased significantly in patients with all types of bearings compared to the control group (pre-operative). The median level of Co in the MePe group was significantly lower than that in the 28 mm, 36 mm, and the ASR® groups (p<0.01). After 1 year, the levels of Co in patients with MM bearings were still higher than the levels observed in the control and MePe groups. However, no significant differences were observed between the 28 mm, 36 mm, and ASR® groups.

Figure 2 shows that after 0.5 year, the median Cr levels increased significantly in patients with MM bearings compared to those of the control group. The level of Cr in the MePe group was not significantly different to that of the control and 36 mm groups but was significantly lower than that in the 28 mm and the ASR® groups (p<0.01). The level of Cr was also significantly lower in the 36 mm group compared to that of the 28 mm and the ASR® groups (p<0.02). After 1 year, the levels of Co in patients with MM bearings were higher than the levels observed in the control and MePe groups. However, no significant differences were observed between the 28 mm, 36 mm, and ASR® groups.

DISCUSSION AND CONCLUSION

Results of the present study show that the levels of Co and Cr ions in whole blood of patients with MM prostheses were comparable to those observed in patients with hip resurfacings. This is similar to what was recently described by Daniel et al. where the levels of Co and Cr in whole blood of patients with Birmingham resurfacings were not significantly different to those observed in patients with 28 mm-head THA. Finally, the levels of both Co and Cr were in the same range as those reported in previous studies with different resurfacing bearings where Co levels varied from 1.2 to 3.3 ppb (20 to 56 nmol/L) and Cr levels varied from 2.0 to 4.9 ppb (38 to 94 nmol/L).

Metal ions have the potential to induce the production of reactive oxygen species (free radicals). Since the type of damage that a free radical produces depends on its origin and its type, it is imperative to measure different types of damages. In the present study, we measured the concentrations of three oxidative stress markers in patients with MM bearings. Results show that there were no changes in the levels of these markers in patients with MM bearings compared to those of the control group or to those of patients with MePe bearings. However, as observed for the development of cancer, a long latency period may be necessary to observe an increase in these markers. Longer follow-ups are then required to determine conclusively the effects of elevated circulating ions on oxidative stress in blood of patients with MM bearings.

In conclusion, results showed that patients with hip resurfacings had similar metal ion levels to those of patients with MM hip prostheses and that the increased metal ion levels (compared to control) had no effect on the three oxidative stress markers we studied in the blood of these patients.

REFERENCES