Placental Regulation of Metal Transfer in Patients with Metal-metal Surface Replacement Hip Arthroplasty
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INTRODUCTION
Metal-metal (MM) surface replacement arthroplasty of the hip is showing promise as an effective and enduring solution in the management of hip arthritis in the young, and is being increasingly used. The main concern is the invariable release of metal ions into the systemic circulation. Providentially, cobalt and chromium are essential elements in the body, by virtue of which, there are mechanisms of handling these ions at various physiological interfaces.

Many long-term effects of elevated systemic metal ion concentrations are not fully elucidated. There is concern that metal ions cross the placenta in pregnant women with MM bearing arthroplasties with the potential for mutagenic effects in the offspring. Two earlier reports1 2 with more limited numbers of specimens offer conflicting conclusions. This report is an update on one of the above2 and seeks to establish in a larger cohort of patients, if the raised concentrations of cobalt and chromium ions in maternal blood lead to elevated levels in umbilical cord blood of the baby. The hypothesis is that metal ions pass freely through the placenta and that there is no difference in the maternal and cord metal ion levels.

MATERIALS AND METHODS
This is a controlled cross-sectional study of women of child-bearing age with MM bearing surface replacement arthroplasties. (n=22, mean age: 32 years, mean duration after resurfacing 60.3 months, 3 bilateral). The control group consisted of 24 subjects who do not have a metallic implant, were not taking any supplements containing cobalt or chromium salts and were registered to undergo an elective LCS at the regional hospital. Mean age of the control group was 31.3 years (range 22 to 37 years). No patient in either group was known to have renal failure. Details of the specimen collection and the measures taken to prevent contamination were published in an earlier report.2

Whole blood specimens were obtained from the mothers just before delivery and before infusion of any fluids, and cord blood specimens were obtained immediately after delivery. High resolution inductively coupled mass spectrometry (HRICPMS) was used for metal ion analysis.

RESULTS
None of the babies born in either of the two cohorts was diagnosed to have a congenital anomaly. Cobalt and chromium were detectable in all specimens (mothers and umbilical cords) in both the study patients and patients with MM THA? Jl Arthroplasty 2004;19(8)suppl: S102 – 106. 

In the study group, mean cord metal ion levels were significantly lower than the maternal cobalt (p < 0.05) and chromium (p < 0.0001) levels thus rejecting the null hypothesis.

Individual concentrations of chromium in cord blood (range 0.09 to 1.03 µg/L) were lower than the corresponding concentration in the maternal blood (range 0.35 to 2.87 µg/L) (except in one specimen where the cord level was marginally higher). The trend was similar with cobalt (range of cord blood levels 0.35 to 3.11, and maternal blood levels 0.42 to 5.06 µg/L) with all specimens except two being lower in the cord blood.

In the control group, the mean metal ion levels in the cord blood differed from the maternal levels by only 5 to 7% (figure 2) and neither difference was statistically significant (p > 0.5).

The mean difference in cord chromium between the study (0.33 µg/l) and control groups (0.21 µg/l) was not found to be statistically significant (p > 0.05), although the mean cord cobalt in the study group (0.98 µg/l) is significantly higher (p < 0.01) than that in the control group (0.41 µg/l).

Whilst there is a four-fold elevation of maternal cobalt in the study patients (1.71/0.44) and an almost 7-fold increase in maternal chromium levels (1.39/0.2) as compared to the control group, the elevation in the cord cobalt and chromium in the study group are smaller.

REFERENCES

SUMMARY AND CONCLUSION
In summary, cobalt and chromium cross the placenta, irrespective of the presence of metal devices. The placenta exerts a regulatory effect on the rate of metal transfer. At low maternal metal ion levels there is a relatively higher transfer rate as percentage of maternal level than at higher levels.

In view of the above findings there is a continuing need to monitor metal ion levels in patients with metal on metal devices. Furthermore, inasmuch as all the effects of raised metal ions are not fully understood yet, there is a need to continue efforts to reduce metal ion release from artificial joints.

DISCUSSION:
The differences between maternal and cord metal ions in the control patients is very small and indicate that, under the circumstances of normal internal milieu, the placenta allows an almost free passage of metal ions. This is understandable when we realize that these elements are also required by the developing foetus for its cellular and metabolic functions.

The relative levels of metal ions in the maternal and cord blood in the study group patients reveal that the placenta does exert a modulatory effect on metal transfer. The mean cord levels of cobalt and chromium in these patients are only 57% and 24% of the maternal blood levels respectively (fig 2).