The taper junction contributes one third of the total volumetric material loss in large diameter metal-on-metal hip arthroplasties

Summary

The taper junction is an important source of implant-derived metal debris but in the majority of cases contributes significantly less to the overall volumetric material loss than the bearing surfaces.

Introduction

There have been several reports of higher failure rates for stemmed large head metal-on-metal (LH-MOM) hip arthroplasties when compared to the same bearing used as a resurfacing. This has been attributed to material loss from the head-stem taper junction. The contribution of the taper junction to the total material loss remains poorly understood. The purpose of this study was to quantify the volumetric wear of both bearing surfaces and the taper junction, and investigate any relationships with blood metal ion levels and commonly reported clinical variables.

Methods

This was a study of 48 consecutively collected stemmed LH-MOM retrieval cases. The series included several contemporary designs of MOM hip. We recorded all relevant clinical data, including pre-revision whole blood cobalt and chromium ion levels and component position. Volumetric wear of the bearing surfaces was measured using a coordinate measuring machine, and of the taper surface (Figure 1) using a roundness measuring machine.

Results

The mean volumetric wear of the bearing surfaces (combined head and cup) was significantly higher than the volumetric material loss at the taper (Table 1). Similarly the mean contribution of the bearing surfaces to the total material loss was significantly greater than that from the taper (Table 1). In only 13 (27%) of the 48 cases was the volumetric material loss greater at the taper surface compared to the bearing surface (Figure 2). Total material loss (bearing and taper surfaces) showed a strong significant correlation with both cobalt and chromium ion levels (Figure 3; $p < 0.001$).

Discussion and Conclusions

Although the bearing surfaces are the predominant source of wear debris in the majority of cases, the taper junction contributes one third of the total material loss in retrieved LH-MOM hip arthroplasties. The mechanism of material loss at the bearing surface is mechanical wear, resulting in the release of metal particulate debris. In contrast corrosion at the taper surface results in the release of metal ions. Therefore, although contributing less to

the total volume, the material lost from the taper junction may be more biologically active. The taper junction is a clinically important source of material loss and is likely to contribute to the higher failure rates reported for LH-MOM hip arthroplasties.

Table 1: Summary of Volumetric Wear Data

	Bearing Surface Wear			Taper Wear	Combined Bearing Surface versus Taper
	Cup	Head	Combined		
Mean (range) wear volume (mm^3)	14.7 (0.1-194.8)	11.7 (0.3-137.4)	26.4 (0.6-254.0)	4.9 (0.3-25.2)	p = 0.003
Mean (range) percentage contribution to total prosthesis wear volume (%)	27.6 (1.1-84.9)	36.7 (1.0-85.3)	64.3 (13.6-99.3)	35.7 (0.7-86.4)	p < 0.0001

Figure 1

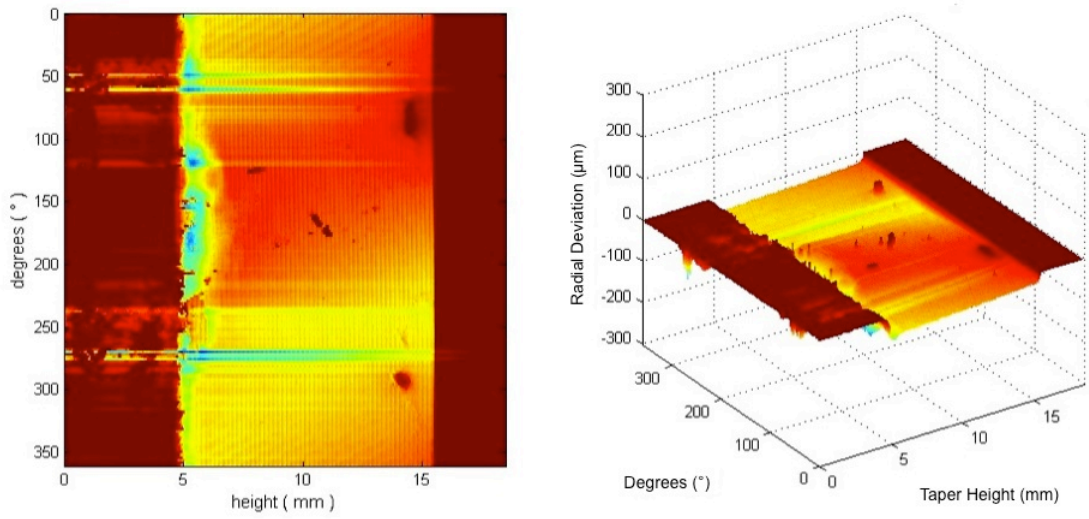


Figure 2

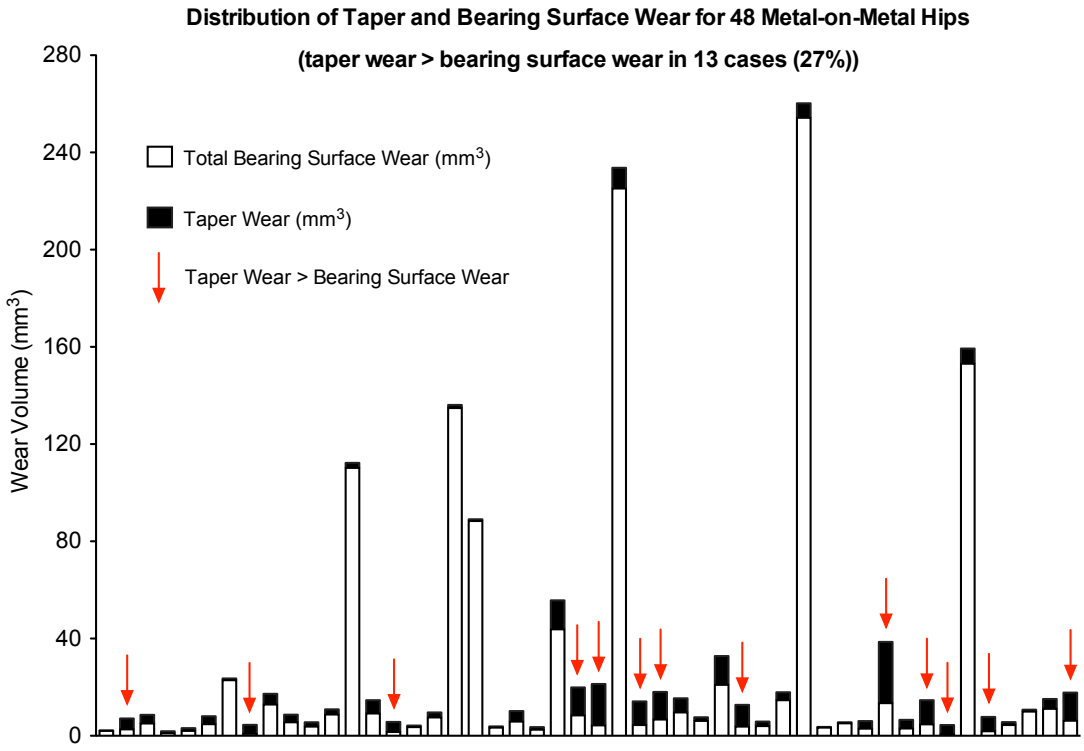
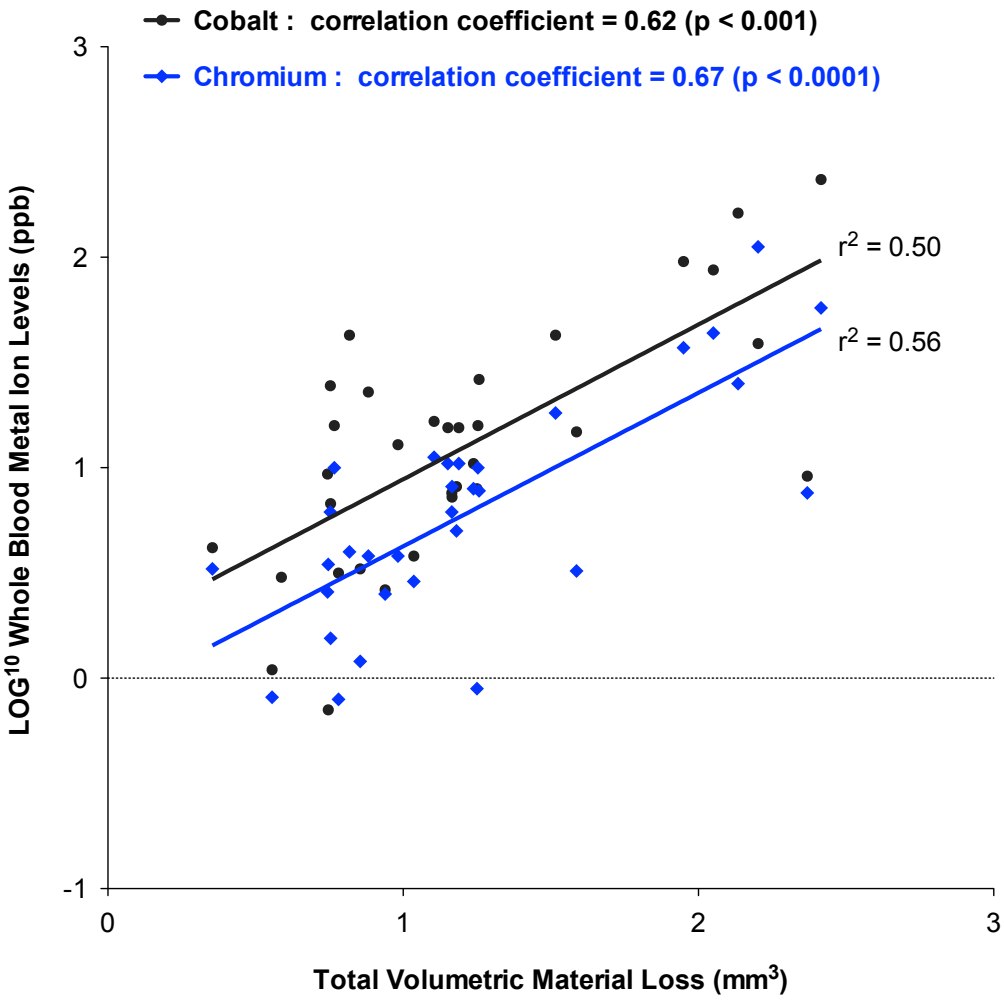

Distribution of Taper and Bearing Surface Wear for 48 Metal-on-Metal Hips
(taper wear > bearing surface wear in 13 cases (27%))
Total Bearing Surface Wear (mm3)
Taper Wear (mm3)
Taper Wear > Bearing Surface Wear
Wear Volume (mm3)
280
240
200
160
120
80
40
0

Figure 3


Cobalt : correlation coefficient = 0.62 (p < 0.001)
Chromium : correlation coefficient = 0.67 (p < 0.0001)
r2 = 0.50
r2 = 0.56
LOG10 Whole Blood Metal Ion Levels (ppb)
Total Volumetric Material Loss (mm3)
3
2
1
0
-1
0
1
2
3