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Primary Arthroplasty

Increased Femoral Head Offset is Associated With Elevated Metal Ions in Asymptomatic Patients With Metal-on-Polyethylene Total Hip Arthroplasty

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ABSTRACT

Background: Predisposing factors for trunnionosis and elevated metal ion levels in metal-on-polyethylene (MOP) total hip arthroplasty (THA) are currently unknown.
Methods: This retrospective cohort study enrolled 80 consecutive patients (43 males) with an asymptomatic MOP THA at 2- to 5-year follow-up and no other metal implants. Serum cobalt (Co) and chromium (Cr) levels were collected at the time of enrollment, and retrospective review was performed regarding demographic, implant, and surgical characteristics. Mean age at the time of surgery was 65.7 years (range 35.6-85.9 years), and mean postoperative follow-up was 28.7 months (range 24.4-58.9 months).
Results: Femoral head offset was the only evaluated factor shown to increase serum Co ion levels above baseline within the cohort. Mean difference in Co level for high and low offset implants was 0.58 ppb (95% confidence interval [CI] = 0.05-1.11 ppb; $P = .03$). Mean difference in Cr level for high and low offset implants was 0.19 ppb (95% CI = −0.23 to 0.60 ppb; $P = .37$). Mean difference in Co level for small and large femoral heads was 0.20 ppb (95% CI = −0.41 to 0.81 ppb; $P = .59$). Mean difference in Cr level for small and large femoral heads was 0.28 ppb (95% CI = −0.18 to 0.74 ppb; $P = .06$). Age, gender, Harris Hip Score, and implant duration were not associated with changes in metal ion levels.
Conclusion: Femoral head offset appears to be an important source of elevated metal ion levels in MOP THA. Further studies will be needed to understand if increasing femoral head offset is associated with subsequent adverse local tissue reactions.

Femoral head modularity allows surgeons the ability to quickly and efficiently change femoral length and offset intraoperatively. However, there have been concerns about femoral corrosion at the modular junction secondary to multiple modes of corrosion [1-3]. Recently, a series of 10 patients were identified with adverse local tissue reactions (ALTRs) secondary to metal-on-polyethylene (MOP) total hip arthroplasty (THA) [4]. Patients presented with elevated serum levels of cobalt (Co) and chromium (Cr) metal ions as well as pseudotumors similar to previously described ALTRs in metal-on-metal THA [5].

Elevated serum Co and Cr levels have been attributed to excessive corrosion at the modular junction in patients with MOP THA [6,7]. Femoral heads composed of cobalt–chromium alloy were used in all reported cases of ALTR in patients with MOP THA. However, there is little information available on predisposing risk factors for developing elevated metal ion levels and subsequent ALTR in MOP THA [8]. Femoral head size has been speculated to increased metal ion levels, but this has not been proven clinically [9]. In addition, femoral head offset and femoral stem offset may predispose to ALTR secondary to increased stress placed on the trunnion. Furthermore, normal laboratory values for patients with asymptomatic MOP THA have yet to be established. The purpose of this investigation was to identify normal baseline serum metal ion levels in MOP THA patients and determine implant- or

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Table 1
Summary of Individual Patient, Implant, and Serum Metal Ion Characteristics.

Age (y)	Follow-Up (mo)	Sex	Femoral Component	Stem Size	Head Offset (mm)	Head Size (mm)	Cup Size (mm)	Poly Thickness (mm)	Liner Offset (mm)	HHS @ Final Follow-Up	Cobalt (ppb)	Chromium (ppb)
52	25	M	Summit ha hi	6	−2	40	60	40 × 60	4	100	0.2	0.1
56	27	M	Summit ha hi	4	−2	40	60	40 × 60	4	100	0.2	0.2
54	30	F	Corail ha	10	−2	36	52	36 × 52	4	100	0.2	0.1
78	27	M	Summit ha hi	4	−2	40	56	40 × 56	4	96	0.2	0.2
77	25	F	Summit ha	4	−2	36	54	36 × 54	4	86	0.3	0.5
83	26	M	Corail high offset ha	11	−2	36	56	36 × 56	4	100	0.2	0.2
50	25	F	Summit ha hi	3	−2	36	56	36 × 56	0	96	0.2	0.5
58	26	M	Summit ha hi	7	−2	36	62	36 × 62	0	96	0.2	0.1
64	58	F	Summit ha	5	−2	36	54	36 × 54	4	—	0.2	0.1
55	30	F	Summit hi ha	7	−2	36	54	36 × 54	0	93	0.3	0.1
53	26	M	Summit hi ha	7	−2	36	62	36 × 62	0	—	0.2	0.3
59	24	M	Summit hi ha	6	−2	36	58	36 × 58	0	100	1.2	0.1
73	27	M	Summit hi ha	7	−2	40	58	40 × 58	4	—	0.2	0.2
49	28	M	Summit hi ha	6	−2	40	58	40 × 58	4	96	0.2	0.1
47	30	M	Corail high offset ha	16	−2	40	60	40 × 60	4	100	0.2	0.1
75	27	M	Summit hi ha	7	−2	40	60	40 × 60	0	71	0.2	0.1
78	28	M	Summit hi ha	5	−2	40	56	40 × 56	4	96	0.3	0.1
53	31	M	Summit hi ha	5	−2	44	62	44 × 62	4	96	0.2	0.1
63	26	F	Restoration modular	17 × 155	0	40	62	40 × 62	0	88	0.4	0.1
84	52	F	SROM	18 × 10 × 160	0	32	52	32 × 52	0	100	1.3	1
55	28	F	Fitmore stem	B/6	0	36	58	36 × 58	0	—	0.5	0.1
64	28	M	Secur-fit	12	0	36	62	36 × 62	0	100	0.2	0.3
70	28	M	Secur-fit	10	0	36	56	36 × 56	0	—	0.2	0.2
61	27	F	Corail ha	9	1	32	50	32 × 50	0	97	0.2	0.4
37	27	F	Summit hi ha	3	1	32	52	32 × 52	0	100	0.3	0.1
50	27	F	Summit hi ha	1	1	32	52	32 × 52	0	100	0.2	0.1
36	59	M	Summit ha	2	1	32	50	32 × 50	0	—	0.2	0.2
44	29	F	Summit hi ha	2	1	32	54	32 × 54	0	100	0.2	0.2
77	27	M	Summit ha	7	1	32	54	32 × 50	0	85	0.2	0.1
73	29	F	Corail ha	12	1	32	54	32 × 54	0	100	0.2	0.1
67	27	F	Corail high offset HA	10	1	32	50	32 × 50	0	96	0.3	0.1
57	25	F	Corail HA	11	1	32	48	32 × 48	0	100	0.2	0.2
78	27	F	Corail HA	11	1	32	54	32 × 54	0	—	0.2	0.2
77	27	F	Summit hi ha	4	1	32	48	32 × 48	4	100	0.2	0.1
65	27	M	Corail ha	13	1.5	36	58	36 × 58	0	100	0.2	0.1
68	36	F	Summit hi ha	3	1.5	36	54	36 × 54	4	96	0.4	6.4
70	27	M	Summit hi ha	7	1.5	40	58	40 × 58	4	94	0.2	0.1
64	27	M	Summit hi ha	6	1.5	36	56	36 × 56	4	100	0.2	0.1
73	27	F	Corail ha	10	1.5	36	54	36 × 54	0	97	0.2	0.4
72	28	F	Corail ha	11	1.5	36	50	36 × 50	0	79	0.9	0.1
63	28	F	Corail ha	10	1.5	36	56	36 × 56	0	100	0.2	0.3
69	27	M	Summit hi ha	7	1.5	40	58	40 × 58	4	100	0.2	0.1
72	27	F	Summit hi ha	6	1.5	36	56	36 × 56	0	100	0.2	0.4
65	26	F	Corail ha	11	1.5	36	54	36 × 54	4	100	0.2	0.1
64	25	M	Summit hi ha	6	1.5	44	66	44 × 66	4	—	0.2	0.3
70	28	M	Corail ha	14	1.5	36	60	36 × 60	0	96	0.2	0.2
65	27	M	Corail ha	12	1.5	36	58	36 × 58	0	100	0.3	0.1
84	28	M	Summit hi ha	4	1.5	40	58	40 × 58	4	100	0.2	0.2
65	26	M	Summit hi ha	8	1.5	36	60	36 × 60	0	100	0.2	0.1
62	27	M	Secur-fit	10	2.5	36	56	36 × 56	0	100	0.4	0.7
65	26	F	SROM	18 × 13 × 160+4L	3	36	52	36 × 50	0	87	0.2	0.1
75	26	F	Fitmore stem	B/6	3.5	32	54	32 × 54	0	—	0.4	0.2
65	27	F	Fitmore stem	B7	3.5	36	58	36 × 58	0	—	0.3	0.8
67	36	M	Depuy AML	19.5	5	40	64	40 × 62	0	97	0.2	0.4
80	27	F	Corail high offset ha	11	5	32	52	32 × 52	0	—	0.2	0.1
56	26	M	Corail high offset ha	12	5	36	58	36 × 58	0	100	0.2	0.1
67	29	M	Summit hi ha	6	5	36	60	36 × 60	0	100	0.2	0.1
85	28	M	Summit ha	5	5	44	64	44 × 64	4	94	8.4	0.4
68	27	F	Corail ha	11	5	32	50	32 × 50	0	88	0.4	0.5
64	26	F	Corail ha	11	5	32	52	32 × 52	0	—	0.3	1.1
73	24	M	Corail ha	15	5	36	60	36 × 60	0	100	0.2	0.1
64	29	M	Corail ha	13	5	36	60	36 × 60	0	96	1.3	0.1
72	28	M	Corail ha	12	5	36	62	36 × 62	0	100	0.2	0.1
61	31	M	Summit hi ha	7	5	36	60	36 × 60	0	100	0.9	0.3
66	26	F	Summit hi ha	3	5	36	54	36 × 54	0	—	0.3	0.3
76	27	F	Corail ha	12	5	36	52	36 × 52	4	73	0.2	0.1
61	24	F	Summit hi ha	4	5	36	54	36 × 54	0	100	0.2	0.1
73	30	M	Summit hi ha	8	5	36	58	36 × 58	0	100	0.4	0.1
69	25	F	Summit ha	5	5	36	56	36 × 56	0	100	0.3	0.5
62	28	M	Corail ha	16	5	40	56	40 × 56	4	100	0.2	0.1
86	26	F	Accolade	4	5	32	50	32 × 50	4	84	0.4	0.1
61	28	M	Reclaim	27 × 240	5	44	74	44 × 74	0	92	0.6	0.5

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