TABLE E-1 Clinical Findings with Hydroxyapatite-Coated Hip Stems

Study Authors	Stem Type	No. Hips (Patients)	Age (Years)	Follow-up Time (Years)	No. Hips (Patients) Lost to Follow-up	No. Aseptic Loosening	Comments
Capello et al.[51]	Omnifit	316 (282)	50 (16-81)	8.1 (5.6-9.9)	25 (21)	1 (0.3%)	No intramedullary osteolysis.
D'Antonio et al.[53]	Omnifit	314 (274)	51 (18-81)	11.1 (10-13)	15 (13)	2 (0.5%)	100% of non-revised stems bone-stable. One patient had osteolysis threatening fixation.
Geesink[50]	Omnifit	118 (99)	53 (21-73)	12 (11-13)	2 (1)	0	Osteolysis minor and confined to calcar resection level.
D'Lima et al.[59]	Omnifit	59 (55)	52 (26-74)	3.5 (2-5)	4 (4)	0	No endosteal lysis. Calcar lytic lesions correlated with wear (mean 0.30 mm/yr with lesion and 0.17 mm/yr without lesion).
Capello et al.[54]	Omnifit	164	39 (16-49)	6.4 (5-8.3)	12	0	All hips radiographically osseointegrated. Intramedullary osteolysis suspected in 1 hip; otherwise, lysis minimal and confined to Gruen zones 1 and 7.
Capello et al.[56]	Omnifit	229 (201)	56 (45-73)	10.8 (10-14)	-	1 (0.4%)	Osteolysis in zones 1 and 7 for 38% of patients over 45 and for 48% of patients less than 45 years old. No intramedullary osteolysis.
		41 (36)	35 (18-44)	10.3 (10-13)		1 (2.4%)	
Capello et al.[55]	Omnifit	123 (106)	39 (18-49)	11.3 (9.6-13.8)	8 (7)	1 (0.9%)	Continuation of previous study[50]. All unrevised stems stable. Osteolysis confined to zones 1, 7, 8 and/or 14 in 49 (47%) of stems. There was no intramedullary osteolysis.
Geesink and Hoefnagels[57]	Omnifit	61 (58)	58 (34-75)	4.4 (0.6-8.5)	0	2 cases of radiographic loosening	All revision cases. 88% used the primary Omnifit stem. Minor osteolysis in zones 1 and 7.
Takahashi et al.[60]	Omniflex	75 (72)	61 non-HAC	6.5 (5.1-8.0)	0	0	Surface was arc-deposited titanium with or without HAC. Minor osteolysis in 3 non-HAC and 1 HAC hip.
			64 HAC	4.3 (3.0-5.1)	0	0	
Rossi et al.[61]	Anatomique Benoist Girard (ABG)	100 (100)	63 (25-76)	(2-3.8)	0	0	
Garcia Araujo et al.[62]	ABG	33 (32)	51 (25-78)	5 year minimum	0	0	RA patients. 44% under 50 years old. Stems radiographically stable.
Tonino and Rahmy[63]	ABG	398	64 (25-86)	(5-7)	Not stated	0	Bone-remodeling mainly completed at 3 years. Small osteolytic lesions in zone 7a for 6 hips with high wear.
Giannikas et al.[65]	ABG	71 (66)	55 (26-65)	4.8 (2-7)	1 record review, one telephone review	0	Eccentric wear in 37 (60%) of hips. One case of endosteal cavitation.
Rogers et al.[67]	ABG	100 (97)	51 (22-71)	6 (4-10)	None stated	0	High polyethylene wear. 6% had bone resorption in zone 1 and 11% in zone 7.
McNally et al.[68]	Furlong	100 (86)	(45-94)	10 (9-12)	0	0	
Vedantam and Ruddlesdin[69]	Furlong	54 (45)	55 (33-73)	4.9 (2-6.5)	Not stated	1 (1.9%)	Radiographs indicated that fixation achieved in the distal 2/3 of stem.
Loupasis et al.[70]	Furlong	47 (42)	46 (31-50)	5.9 (3.8-7.4)	1	0	Non-revised stems radiographically stable. Calcar osteolysis in 3 hips. No distal osteolysis.
Loupasis et al.[71]	Furlong	82 (76)	55 (37-67)	5.4 (4-6.8)	1	0	All stems radiographically stable. Small progressive lesions in zone 7 for 3 (4%) of stems.
Reikeras and Gunderson[73]	Landos Corail	323 (276)	48 (15-79)	10 (8-12)	19	1	Fibrous ingrowth adjacent to proximal part of stem in 16 cases. Focal osteolysis in zones 1 and/or 7 in 28 cases. High wear in many cases.
Rokkum and Reigstad[74]	Landos Corail	100 (86)	56 (32-73)	5	None stated	0	Stems stable, but by 5 years 74/94 stems exhibited double radiolucent lines indicating fibrous tissue. High wear noted.
Gosens et al.[76]	Mallory-Head	63 (50)	53 (20-68)	6.3 (3.7-9.8)	None stated	0	No osteolysis noted. Cortical hypertrophy in zones 3 and 5.
Hernandez Cortes et al.[77]	Ti-Fit	60 (60)	65 (45-76)	11	7	1	Calcar osteolysis seen in 8 hips and one case of distal osteolysis. 48 remaining stems stable. Thigh pain in 30% of patients.
Skinner et al.[78]	Freeman	100 (100)	57	10	3	0	
Radl et al.[79]	Austria	142 (136)	66.5 (19-90)	5.6 (4.3-7.3)	5	3	Stem migration >2 mm in 29 hips. Bone loss seen in all patients. Conclusion that design did not give adequate press-fit stability.
Yee et al.[81]	Mallory-Head	35 HAC	48.2 ± 9.0	4.4 ± 0.7	Not stated	0	Randomized trial. No significant clinical difference between groups. Two non-hydroxyapatite stems had distal endosteal cavitation. Calculated volumetric wear statistically same in both groups.
		27 non-HAC	50.4 ± 8.7	4.9 ± 1.0		0	
Sharp et al.[118]	C-Fit	91 (78)	< 66	5.2 (0.1-8)	4 patients	16	Randomized trial comparing HAC to non-HAC stems abandoned after 4 years due to poor performance in both arms of study.
Buoncristiani et al.[85]	Anatomic Porous Replacement (APR)	66 (65)	58 non-HAC	4.7 ± 0.9	Not stated	3	Inhomogeneous revision population. 31/66 stems HAC. Stems with HAC had statistically improved Harris scores for pain and limp.
			55 HAC	4.6 ± 1.0			
Park et al.[82]	Sivash Range of Motion (S-ROM)	48 (24)	54 (29-68)	4.3 (3.9-5.3)	8 (4)	0	24 patients with bilateral op. received HAC and non-HAC device. No difference in remodeling or hip scores. No difference in wear.
Kim et al.[83]	Immediate Postoperative Stability (IPS)	100 (50)	45 (27-61)	6.6	Not stated	0	Fifty patients with bilateral op. received HAC or non-HAC device. Equivalent Harris hip score. Wear was 0.18 ± 0.012 mm/yr for HAC group and 0.21 ± 0.014 mm/yr for non-HAC group.
Hamadouche et al.[84]	Profile	50 (46)	65.3 HAC	9.08 ± 0.81	1	1	24 HAC and 26 non-HAC. Stem subsidence statistically lower for HAC group.
			64.3 non-HAC	8.25 ± 1.91	2	2	
Santori et al.[80]	Anatomic	(371)	Not given	5.8 (5-7)	Not stated	6 stems revised	227 patients available: (A) 69 fiber metal; (B) 90 with HA/TCP coating on fiber metal; (C) 68 with HA/TCP coating extended to cover proximal half of stem. No difference between groups B and C. Better clinical results and radiographic results for groups B and C. Group A had greater thigh pain.

HAC = hydroxyapatite-coated. Age and follow-up time given as the average with the range in parentheses.

TABLE E-2 Clinical Findings with Hydroxyapatite-Coated Cups

Study Authors	Stem Type	No. Hips (Patients)	Age (Years)	Follow-up Time (Years)	No. Hips (Patients) Lost to Follow-up	No. Aseptic Loosening	Comments
Manley et al.[58]	Dual Geometry (PC)	109 (102)	50 (16-81)	7.9 (5.3-9.1)	15 (13)	2 (2%)	PC = porous-coated. Press-fit cups had higher failure and osteolysis rates. Mechanical interlock needed for initial stability to prevent loosening.
	Dual Geometry (HAC), Dual Radius (HAC)	188 (168)				21 (11%)	
	Threaded (HAC)	131 (107)				1 (1%)	
Epinette et al.[99]	Arc2f	418 (384)	65 (21-88)	Minimum 10	5 (4)	2	No cup migration. Survivorship > 99%. Minimal osteolysis. Threaded HAC cup compares favorably to best cemented and cementless designs.
Jazrawi et al.[101]	Secur-Fit (HAC)	25 (23)	58 (35-75)	Minimum 4	0	0	Secur-Fit cups with rough surface had fewer radiolucent lines. Four cases of periacetabular osteolysis in each group.
	Dual Radius (HAC)	25 (25)	60 (26-77)				
Siverhus and Bryant[102]	Secur-Fit (HAC)	93 (78)		4.3	5	0	
Chung et al.[90]	Anatomique Benoist Girard (ABG)	289	58.6*	4.6*	Not stated	10	*Age and follow-up refer to patients with 29 cups revised. Absorption of HAC noted; extent averaged 60.5%. Wear of retrievals averaged 0.288 mm/yr. Conclusion that mechanical interlock or fixation surface required.
Van Hoye et al.[88]	ABG	26 (18)	71	2	Not stated	0	ABG cup used for revision procedures.
Nivbrant and Kärrholm[89]	ABG	29 (28)*	65 (30-83)	2	Not stated	0	*Revision procedures. **Primary procedures. Radiostereometric analysis. Mean proximal wear for all cups 0.11 mm/yr. ABG cups displayed “smallest migration so far reported in revision arthroplasty.”
		14 (14)**	49 (35-63)	2	Not stated	0	
Havelin et al.[95]	Atoll	772	55	Median 1.1	n.a.	0	Norwegian Arthroplasty Register. Atoll HAC press-fit. Tropic HAC screw-thread.
	Tropic	1171	56	Median 3	n.a.	1	
Rokkum and Reigstad[119]	Tropic	79 (73)	57 (32-73)	5	n.a.	2	Radiographic wear study. No. Hips refers to those evaluated at 5 years. Wear rate increased with time.
Rokkum et al.[98]	Tropic	100	56 (32-73)	(7-9)	0	5	Revision due to wear in 18 hips with 6 more scheduled. Osteolysis in 66 hips. Radiographically, double lines developed along stems in 82 hips.
Reikeras and Gunderson[96]	Atoll	191 (155)	47 (15-78)	(7-10)	5	41	Pattern of failure: HAC resorbs or delaminates, causing instability. Conclusion that better mechanical interlock needed for this press-fit design.
Lai et al.[97]	Atoll	85 (74)	50 (29-71)	10	4 (3)	14	Stem survivorship much higher than that of cup. For loose cups, mean loss of hydroxyapatite was 50% after 2 years compared with a loss of 22% for stable cups. Conclusion was that HAC cannot substitute for mechanical stability.
Havelin et al.[120]	Atoll	1218		Risk of revision beyond 4 years	n.a.	45	Norwegian Arthroplasty Register. Atoll performance worst. Tropic performance with alumina head equivalent to Charnley but risk ratio 3.4× with stainless steel head. Wear and osteolysis more common with Atoll and Tropic.
	Tropic	2658			n.a.	24	
	Charnley	16,162	Charnley patients older		n.a.	106	
Badhe et al.[94]	Bi-Contact	153 (138)	71 (41-94)	6.8 (5-9)	7	3 (HAC), 0 (non-HAC)	Randomized study comparing 66 HAC to 87 non-HAC cups of same design. No stem loosening.
Mann et al.[100]	Furlong HAC Screw Cup	173 (150)	70	6.5 (5-9)	12	3	Authors concluded that HAC was mandatory if a screw cup was used. Low level of polyethylene wear linked to use of ceramic head even though head diameter 32 mm.
Badhe and Howard[104]	Stemmed HAC Cup (McMinn-Link)	29	70 (28-86)	3.8 (1.1-6.1)	0	0	22 revisions and 7 complex primary procedures requiring bone grafting.
Moilanen et al.[121]	Superior Lateral Flange (SLF)	69	59.7 HAC	2.3	Not stated	0	Similar clinical results for two groups. Tendency for HAC cups to have lower rate of proximal migration (wear) and significant reduction in rotational migration and number of radiolucent lines.
		40	62.6 non-HAC	3.4	Not stated	0	
Thanner et al.[105]	Harris-Galante-II	23 HAC, 23 non-HAC	HAC and non-HAC matched	2	0	0	Radiostereometric analysis. HA/TCP coating. HA/TCP cups had significantly lower rotation. No difference in femoral head penetration between groups.
Thanner[106]	Triology	34 no holes, 30 holes	56 (32-75)	2	0	0	Radiostereometric analysis. HA/TCP coating in all patients. No difference in migration whether holes (screws) or not holes in shell. No difference in wear. Conclusion was that screws not needed for stability.

HAC = hydroxyapatite-coated. Age and follow-up time given as the average with the range in parentheses.