

Severe polyethylene wear in uncemented (AML) total hip arthroplasty

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A report of five cases

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Abstract:

We report five cases of severe failure of the polyethylene liner at 4-7.4 years following uncemented AML total hip arthroplasty, using the Acetabular Cup System (ACS). The mode of failure was by a combination of wearthrough to the metal backing and liner fracture. Four of the five cases were associated with a 32mm head. The ACS design is flawed because of a lack of hemispherical geometry resulting in rim loading on a region of the liner that has the thinnest polyethylene. All patients with this type of implant should be monitored for evidence of excessive polyethylene wear.

Introduction:

Modular metal backed acetabular cups provide a metallic surface for biological fixation and exchange of the polyethylene liner in cases of excessive wear. However, metal backing compromises the maximum thickness of polyethylene liner that can be inserted. Thinner polyethylene predisposes to higher wear rates (1) from the generation of particulate debris. The thickness of the polyethylene liner inserted is also influenced by the size of the femoral prosthetic head used. Additionally oxidative degradation of polyethylene is dependent on its method of sterilisation.

We describe five cases of polyethylene liner failure in a single design of an uncemented hip prosthesis.

Patients & Methods:

Five patients complaining of pain and clicking with radiographic evidence of excessive polyethylene wear after a successful hip arthroplasty for osteoarthritis were reviewed. The mean age of the patients at the time of primary arthroplasty was 56 years (range 50-61);

there were four females and one male. All patients had an AML uncemented hip arthroplasty using the “ Tri-Lock” metal backing and the ACS polyethylene liner (DePuy). This system consists of a porous coated titanium metal shell with a modular polyethylene liner snapped into the rim of the shell at the time of operation. The polyethylene was manufactured by RAM extrusion and was sterilised with gamma irradiation in air. In all cases the femoral component was porous coated, made from cobalt-chrome using a modular head.

Acetabular component dimensions and femoral head sizes were recorded. Acetabular abduction angles were measured from an AP pelvis x-ray. The mode of failure of the liner and the presence of metallosis was noted at revisional surgery.

Results:

The results are shown in table 1.

The time to failure was between 4-7.4 years.

No patient had an acetabular abduction angle greater than 50°. Four patients had a 32mm head and one had a 28mm head. The original dimensions of the ACS liner are shown in table 1. The maximum thickness of polyethylene at the rim in this series was 4.5mm. At the time of revision, all polyethylene liners had evidence of excessive wear and fracture, particularly at the superior rim, (Fig.1). In all cases the metal shells were securely fixed despite metallosis. Bone graft was required at revision for all patients.

Discussion:

The early failures in the cases appears to be related to the design of the prosthesis.

The ACS design does not allow a hemispherical polyethylene liner. The liner bears weight with the metal shell at its periphery. Hence the greatest shear forces borne by the

cup are at its rim where the thickness of the polyethylene is least. All the specimens retrieved at revision showed marked wear and polyethylene fracture at the superior rim. In this series the polyethylene thickness at the rim was between 2.5-4.5mm. Bartel et al.(1) have shown by finite element analysis that stress in polyethylene rises dramatically below 6mm thickness.

Four of the five cases in our series had a 32mm femoral head component. Although a larger femoral head size reduces contact stress on polyethylene, the polyethylene liner has to be thinner to accommodate it.

All polyethylene liners were gamma irradiated in air. It is possible that this method of sterilisation may have contributed to the failure of the liner.

Bono et al (2) described 15 patients with failure of this prosthesis. In two cases the cup abduction angle was greater than 65°, which might have caused the liner to toggle. None of the five cases in our series had abduction angles greater than 50°.

At revision, all cases had metallosis and required bone graft for acetabular osteolytic lesions.

The ACS polyethylene liner is no longer available. It has been replaced with a hemispherical polar bearing liner (Enduron) which is gamma irradiated in an inert medium and accommodates a 28mm head size.

Because of these reports we recommend that all AML hip prosthesis which have used the ACS liner should be monitored for signs of excessive wear and early failure.

References

1. **Bartel DL, Bicknell VL, and Wright TM.** The effect of conformity, thickness and material on

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- 2. Bono JV, Sanford L, and Toussaint JT.** Severe Polyethylene Wear in Total Hip Arthroplasty. J Arthroplasty; (Vol. 9) 2: 119-125, 1994.

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Table 1. Summary of results.

Case	Metal shell size/ mm	Head size/ mm	Cup angle	Polyethylene thickness/ mm		
				Rim	Dome (apex)	Dome (max.)
1	58	32	50°	3.7	7.4	9.4
2	64	32	40°	3.7	7.4	9.4
3	56	32	40°	2.5	5.1	6.4
4	56	28	45°	4.5	7.1	8.4
5	58	32	45°	3.7	7.4	9.4

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Fig. 1. Photograph of retrieved ,disintegrated ACS polyethylene cup.