

## The Influence of Locking Mechanism on Screw-Hole Osteolysis and Backside Damage in Long-Term Acetabular Liners Retrieved from Revision Total Hip Arthroplasty

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**Introduction:** The purpose of this study was to compare the incidence and location of osteolysis as well as the magnitude of backside damage found on long-term retrievals from three different acetabular liner designs.

We hypothesized that liners with a modern locking mechanism would reduce both the incidence of screw-hole osteolysis and the amount of backside damage.

**Materials and Methods:** A total of 111 UHMWPE acetabular liners from two manufacturers were retrieved from revision hip replacement. Of these liners, a total of 53 had been implanted for more than 5 years and were selected for this study, including 16 Impact and 6 RingLoc (Biomet, Inc.) plus 31 MicroSeal (Signal Medical, Inc.) liners (Table 1). All Biomet liners were sterilized with  $\gamma$ -radiation in air or in Ar gas but not otherwise cross-linked, with locking mechanisms consisting of 5-10 tabs in a partial hemispherical shell (Impact) or 12-16 tabs plus a locking ring to resist lever-out within a hemispherical shell (RingLoc), but no mechanism to resist micromotion. All MicroSeal liners were EtO-sterilized but not cross-linked, with a locking mechanism consisting of 6 tabs locking into a cementless titanium shell, with features to seal the interface [1] and resist micromotion and lever-out.

Areas of backside damage, including burnishing and abrasion, were outlined and photographed. After scaling via a reference grid, damaged backside surface area was measured and expressed as a % of total backside projected area [2,3]. All specimens were then re-melted in a vacuum oven to 150 °C, using the "shape memory" property of UHMWPE to recover partially flattened machining marks and remove damage due to viscoelastic creep [4], then re-examined for backside damage. Specimen means were compared by t-tests with  $p < 0.05$  for significance.

**Table 1.** Summary of the liners examined in this study.

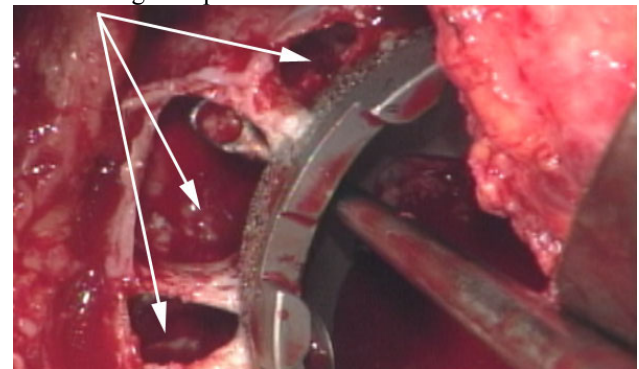
Liner type	No. sterilized by			Age <i>in vivo</i> (years)	
	$\gamma$ -air	$\gamma$ -Ar	EtO	Range	Avg.
Impact	7	9	0	5.32-17.4	13.3
RingLoc	0	6	0	5.10-12.0	9.86
MicroSeal	0	0	31	6.40-12.8	8.95

**Results and Discussion:** A total of 14/16 Impact, 4/6 RingLoc, and 27/31 MicroSeal were revised due to osteolysis. Of these, all hips with liners lacking a seal or micromotion control exhibited screw-hole osteolysis in addition to peripheral osteolysis (Figure 1), and gross motion was observed between the liner and shell. In contrast, only peripheral osteolysis was observed in specimens with sealing and control of micromotion (Figure 2). The liners were tight in their shells, and all shells were well-fixed to bone.

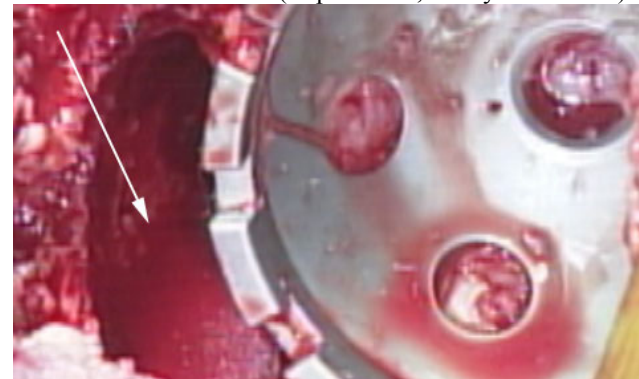
Re-melting the liners recovered some backside damage in the form of partially flattened machining marks, as shown previously [5-7], but only the backside damage of MicroSeal liners was significantly reduced by re-melting

(Table 2). Backside damage (% of total area) was an order of magnitude smaller on MicroSeal liners, even before re-melting, and it is likely that backside damage represented a significant source of wear debris among the liners without sealing or micromotion control.

**Conclusions:** The locking mechanism used in MicroSeal liners eliminated screw-hole osteolysis and all but completely eliminated backside damage, with only 6/31 liners exhibiting damage after re-melting. This study was limited by the measurement of 2D projected area of a curved surface instead of 3D wear volume and the relative lack of RingLoc specimens.



**Figure 1.** Combined peripheral and screw-hole osteolysis, illustrated with a curette (Impact liner, 11.5 years *in vivo*).



**Figure 2.** Osteolysis limited to the periphery of the acetabular shell (MicroSeal liner, 10.7 years *in vivo*).

**Table 2.** Backside damage before and after re-melting.

Liner type	Mean backside damage (% of max.)		
	As retrieved	Re-melted	p-value
Impact	44.5	36.7	0.149
RingLoc	27.5	20.2	0.431
MicroSeal	2.72	0.112	0.0009

**References:** 1. Khalily et al., *J Arthroplasty* 13:254, 1998. 2. Grochowsky et al., *JBMR* 79B:263, 2006. 3. Akbari et al., *Trans Soc Biomater* 290, 2009. 4. Chun BC, *J Appl Polymer Sci* 83:27, 2002. 5. Muratoglu et al., *J Arthroplasty* 19:68, 2004. 6. Lazzarini et al., *CORR* 485:128, 2007. 7. Mimnaugh et al., *J Arthroplasty* 24:303, 2009.