Introduction: The Dynesys® Dynamic Stabilization System (Zimmer Spine) consists of pedicle screws (Ti alloy), polycarbonate urethane (PCU) spacers, and a polyethylene-terephthalate cord. Short-term (mean=2.8 y) clinical results have shown significant decreases in Oswestry score and VAS and no significant disc degeneration at follow-up [1]. Prior studies investigating in vivo degradation of spacer components demonstrated small changes in spacer surface chemical composition after up to 5.5 y implantation [2-4]. The objective of the current study was to examine the deformation, wear, and biostability of retrieved PCU components of Dynesys systems.

Materials and Methods: Ten retrieved (mean implantation 1.8 y, range: 0.7-4.2 y) and 2 exemplar implant systems were available for evaluation. Implants from single (n=3) and multi-level (n=7) systems were examined (44 spacers). Reasons for revision and complications were persistent low back pain (9/10) and screw loosening (7/10). One of the patients with screw loosening had migration of the implants into the patient’s spinal canal (1/10).

Components were cleaned and examined microscopically. PCU spacers are cut at the time of the index surgery, leaving one cut and one molded end. Changes in chemical structure on the cut and molded ends of all PCU spacers were evaluated using attenuated total reflectance (ATR) FTIR (Thermo Electron Corp). In addition, regions of damage that were identified as abrasive wear or surface damage were examined in 32/44 components. Baseline-corrected peak areas in the region from 1650-1800 cm⁻¹ were determined and normalized relative to the aromatic peak area at 509 cm⁻¹. MicroCT (μCT80, Scanco) and scanning electron microscopy (SEM, JSM-6390LV, JEOL) images were obtained on select components for wear evaluations.

Results: Most of the retrieved spacer components exhibited permanent bending deformation, ranging between 0.0 and 15.8 degrees (mean, 4.0 degrees), which was significantly (p<.0014) but weakly (R²=.218) correlated to PCU spacer length (Fig. 2A). Retrieved components also demonstrated evidence of plastic deformation on both surfaces where the cord exited the spacer (Fig. 1A). A focal region of abrasive wear was observed along the length of 27/44 of the spacers (Fig. 1B), which was likely the result of impingement with surrounding bony structures. One spacer exhibited short surface cracks extending from the center to the outer surface (confirmed by μCT).

Significant (ANOVA, p<.05; Fig 2B) decreases in the ATR-FTIR peak areas were observed in the damaged regions of the spacers compared to the cut and molded ends (1698 and 1740 cm⁻¹), as well as compared to exemplars (1698 cm⁻¹ only). However, increased peak heights that were associated with degradation products of PCU [5] were observed in only 2/44 spacers (both from the same patient with 4.2 y implantation time) and only along the side of those spacers (e.g., Fig. 3).

Discussion: The results of the current study indicated that PCU spacers from retrieved Dynesys systems exhibited permanent deformation and, in some cases, focal regions of in vivo wear and surface damage. We found evidence of contact of the PCU spacer with the titanium screws, cord, and adjacent bone. Because interpedicular distance increases cephalically, increasing deformation observed with increasing spacer length could also be related to differences in ranges of motion. Prior biodegradation studies of PCU medical implants demonstrated little change in surface chemical composition [3-4]. In the current study, damaged regions exhibited slight changes in chemical composition compared to undamaged regions and exemplars. Chemical changes that were associated with biodegradation of PCU were only detected on the side surface of 2/44 spacers, where the spacer would be in contact with tissue. All of the implants were revised for clinical reasons unrelated to wear, surface damage, or biostability. Thus, our observations after short-term revision were judged incidental and of limited clinical relevance for these retrievals. Longer-term retrievals are needed to provide greater context for the clinical implications of our short-term observations.


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