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Loss of Cement-bone Interlock in Retrieved Tibial Components from Total Knee Arthroplasties

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BACKGROUND: Aseptic loosening continues to be a short and long-term complication for patients with cemented TKAs. Most studies to this point have evaluated tibial component fixation via radiographic changes at the implant-bone interface and quantification of component migration; direct assessment of morphologic features of the interface from functioning TKAs may provide new information regarding how TKAs function and are fixed to bone.

QUESTIONS/PURPOSES: In a postmortem retrieval study, we asked: (1) What are the morphologic features at the cement-trabecular bone interface in retrieved tibial components? (2) Do constructs with greater time in service have less cement-trabecular bone interlock? (3) Do constructs with more estimated initial interlock sustain more interlock with in vivo service?

METHODS: Fourteen postmortem retrieved tibial components with time in service from 0 to 20 years were sectioned and imaged at high resolution, and the current contact fraction, estimated initial interdigitation depth, current interdigitation depth, and loss of interdigitation depth were quantified at the cement-bone interface. Estimated initial interdigitation depth was calculated from the initial mold shape of the cement mantle that forms around the individual trabeculae at the time of surgery. Loss of interdigitation depth was the difference between the initial and current interdigitation depth.

RESULTS: There was resorption of trabeculae that initially interlocked with the cement in the postmortem retrievals as evidenced by the differences between current interdigitation and the estimated original interdigitation. The current contact fraction ($r^2 = 0.54$; $p = 0.0027$) and current interdigitation depth ($r^2 = 0.33$; $p = 0.033$) were less for constructs with longer time in service. The current contact fraction for implants with 10 or more years in service (6.2%; 95% CI, 4.7%–7.7%) was much less than implants with less than 10 years in service (22.9%; 95% CI, 8.9%–37%). Similarly, the current interdigitation depth for implants with 10 or more years in service (0.4 mm; 95% CI, 0.27–0.53 mm) was much less than implants with less than 10 years in service (1.13 mm; 95% CI, 0.48–1.78 mm). The loss of interdigitation depth had a strong positive relationship with time in service ($r^2 = 0.74$; $p < 0.001$). Using a two-parameter regression model, constructs with more initial interdigitation depth had greater current interdigitation depth ($p = 0.011$), but constructs with more time in service also had less current interdigitation depth ($p = 0.008$).

CONCLUSIONS: The cement-trabecular bone interlock obtained initially appears to diminish with time with in vivo service by resorption of the trabeculae in the cement interlock region.

CLINICAL RELEVANCE: Our study supports the surgical concept of obtaining sufficient initial cement interlock (approximately 3 mm), with the acknowledgment that there will be loss of interlock with time with in vivo service.

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Fig. A–C The graphs show the (A) current contact fraction, (B) estimated initial interdigitation depth and current interdigitation depth, and (C) loss of interdigitation depth as a function of time in service. Specimens with greater time in service had less current contact fraction, less current interdigitation depth, and greater loss of interdigitation depth.

“Constructs with more estimated initial interlock between cement and bone maintained more interlock with time in service. The fractional loss of interdigitation depth appeared to depend primarily on the time in service. Implants with limited initial interlock might be expected to lose a greater proportion of the interlock, and this might explain cases where progressive radiolucencies develop with time.” (p. 312)

“From a clinical perspective, our study showed that it is important to obtain a sufficient level of initial cement-bone interlock because some loss of interlock can be expected owing to trabecular resorption with long-term in vivo service.” (p.312)

“Even with careful preparation, the immediate postoperative contact fraction will likely be less than 100% because the intertrabecular spaces may contain some residual lavage fluid and marrow...” (p. 312)

