ARE CLINICALLY WELL-FUNCTIONING IMPLANTED KNEES MECHANICALLY STABLE?

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**Introduction:**
It has been established that tibial tray loosening is the leading cause of late prosthetic failure in total knee arthroplasty (TKA). However, the investigations concerning tibial tray loosening have studied micromotion in implanted cadaver knees and have not involved mechanical testing of tibial trays retrieved from patients with successful total knee arthroplasties. The present study investigated micromotion at the implant-bone interface of well functioning cemented and cementless knee implants.

**Methods:**
Fifteen tibiae from successful total knee patients (Average age, 76 yrs; range: 68-88 yrs) were retrieved postmortem. The tibial components and the surrounding proximal tibial bone were harvested. The underlying diagnosis for TKA was osteoarthritis in 14 knees and rheumatoid arthritis in 1. The implant designs included 11 AMK knees (Depuy, Warsaw, IN) 2 PCA (Howmedica, Rutherford, NJ) and 2 Synatomic knees (Depuy, Warsaw, IN). Thirteen of the specimens were cemented and two were cementless. These implants remained in situ for an average of 78 months (range: 10-158 months). Specimens were wrapped in saline-soaked gauze and potted in a self-hardening polymer at their distal end. Researchers used a specially designed jig to ensure that the perpendicular axis of the tibial tray was aligned with the loading axis. Specimens were then mounted onto a Mechanical Testing Systems servohydraulic machine (MTS, Minneapolis, MN). An eccentric axial load was applied to each specimen medially and laterally at previously marked loading positions [2]. An extensometer was placed at the medial and lateral side of each tibia to monitor displacement at the tray-bone interface (Fig.1).

![Fig.1 Experimental set up](image)

We adopted three loading configurations. For the first configuration, the lateral plateau was loaded to 500 N in compression at a loading rate of 20 N/sec and then released. For the second, a 500 N compressive load was applied on the medial plateau. For the third, the medial plateau was loaded at a rate of 40 N/sec to two times the patient’s body weight and released (average: 167 lbs; range: 91-290 lbs). For each of these configurations, the researchers measured depression on the loaded side along with the liftoff of the contralateral side.

**Results:**
Micromotion at the implant-bone interface was present in all three loading configurations under eccentric loading. Overall, the average lateral tray depression was greater than the average medial tray depression (28.5 vs. 11.9 microns) for compressive loads of 500 N (p = 0.04, Wilcoxon non parametric test). Researchers also noted a statistically significant difference between medial depression under two times a patient’s body weight and 500 N medial load (28.5 vs. 34 microns), (P = 0.001, Wilcoxon non parametric test). No statistical difference existed between lateral liftoff under a 500 N medial load and medial liftoff under 500 N lateral load (P = 0.35, Wilcoxon non parametric test). Micromotion values averaged 6.5 microns for both. (Table.1)

<table>
<thead>
<tr>
<th>Loading Configuration</th>
<th>Average Micromotion (microns) (mean ± Standard error of the mean)</th>
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<tbody>
<tr>
<td>Lateral Load 500N</td>
<td>Liftoff 8.3 ± 3.4  Depression 28.5 ± 6.9</td>
</tr>
<tr>
<td>Medial Load 500N</td>
<td>Liftoff 4.7 ± 1.7  Depression 11.9 ± 2.8</td>
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<tr>
<td>Medial Load 2BW</td>
<td>Liftoff 15.6 ± 4.4 Depression 34.0 ± 10.3</td>
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**Discussion**
Our results show evidence of micromotion between the tibial tray and the underlying bone in both cemented and cementless implants. They also reveal that mechanical stability is greater on the medial side due to strong underlying bone on the medial plateau as compared with the lateral plateau. According to a study by Branson et al. [1], micromotion values between 50 and 100 microns were present in freshly implanted cadaver tibiae under similar loading conditions. The lower micromotion values of the present study demonstrate that good mechanical stability was present in implants that were in situ for an average of 7 years. This also might suggest that evidence of stability by clinical criteria does not necessarily equate to rigid fixation.

**References**