BIOMECHANICAL MEASUREMENTS OF CORTICAL SCREW-BONE STRIPPING TORQUE
IN HUMAN AND SYNTHETIC FEMURS

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INTRODUCTION
Orthopaedic fracture fixation plates are applied using metal bone screws. Surgeons do this manually by “feel” without monitoring the torque applied. Few studies have measured the stripping torque of bone screws in human bone [1-3]. No studies have measured stripping torque in the synthetic bones increasingly being used in biomechanical studies. The present aim was to measure stripping torque of cortical screws in human vs. synthetic cortical bone.

METHODS
Sixteen fresh frozen human femurs and 8 artificial femurs (Model 3406, Sawbones) were obtained. Standardized bone mineral density (sBMD) and clinical T-score measurements were taken of human femurs with dual energy x-ray absorptiometry (Prodigy, Lunar Corporation). Human femurs were all left-limbed and were 69 +/- 15 years old. A 2.8-mm pilot hole was drilled into the anterior cortex at midshaft, so only cortical bone was engaged. Using a digital torque screwdriver (Model DID-4, Imada), a 3.5-mm diameter unicortical screw (Model 204.014, Synthes Canada) was inserted through the pilot hole until failure of the screw-bone interface (Figure 1). Peak torque and unicortical thickness were measured. Peak torques were normalized by unicortical thickness and by surface area engaged at the bone-screw interface. ANOVA was used for all statistical comparisons with p < 0.05 set as the significance level.

RESULTS
Stripping torques and cortex thicknesses showed no differences for human vs. synthetic specimens (Table 1).

Figure 1. Cross-sectional view of the midshaft segment of a femur specimen. A cortical bone screw was inserted from the top into the anterior cortex.

Table 1. Stripping torque results. Values are averages and standard deviations in parentheses.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Human Femur</th>
<th>Artificial Femur</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute Torque (N.mm)</td>
<td>1741 (442)</td>
<td>2012 (176)</td>
<td>0.51</td>
</tr>
<tr>
<td>Torque/Thickness (N)</td>
<td>185 (63)</td>
<td>201 (18)</td>
<td>0.11</td>
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<td>Torque/Area (N/mm)</td>
<td>16.8 (5.7)</td>
<td>18.3 (1.6)</td>
<td>0.49</td>
</tr>
<tr>
<td>Cortex Thickness (mm)</td>
<td>9.7 (1.4)</td>
<td>10.0 (0.0)</td>
<td>0.49</td>
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</tbody>
</table>

DISCUSSION AND CONCLUSIONS
This study provides further evidence to biomechanical researchers that synthetic femurs manufactured by Sawbones can accurately replicate human femur properties. Given the wide range of human stripping torques obtained, clinicians may wish to monitor torque during screw insertion, rather than using subjective “feel” only, as is currently done clinically. To the authors’ knowledge, this is the first investigation to directly compare human vs. synthetic femurs from Sawbones with regard to stripping torque.

REFERENCES