Coefficient of Friction for Porous Metal Structures Against Cortical Bone

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Statement of Purpose: Porous metal structures have traditionally been used in orthopedic devices to facilitate biological fixation. Surface properties like roughness are critical for better seating of the device and for initial stability post-implantation. High surface roughness usually translates into high coefficient of friction (COF). However, COF values are dependent upon the surface against which the material is tested. In this study, we've analyzed the surface roughness of OsseoTi™ and compared the COF for porous metal structures against bovine cortical bone, swine cortical bone and sawbone blocks representing the density of cancellous bone.

Methods: The surface roughness of OsseoTi™ was determined using optical method. The average roughness was calculated using 30 independent measurements from 10 different samples. To analyze the COF, three different types of porous metal samples: OsseoTi™, Regenerex™ and Trabecular Metal™ (TM) – were analyzed against bovine cortical bone, pig cortical bone, 20 pcf and 40 pcf sawbones. For the bovine and swine bone samples, the soft tissue was carefully removed to expose the cortical bone while preserving the natural texture of the bone specimens on the testing side. The non-articulating back surface of the bone was ground flat to stabilize the bone during testing. A test apparatus was designed to stabilize the sample over the bone surface, and a calibrated load was applied till the initial movement of the sample was observed and this load was recorded. Each test was repeated three times.

Results: The surface roughness for OsseoTi™ was measured at 322 ± 36 micron. The friction testing showed that the COF for OsseoTi™> Regenerex™ > Trabecular Metal™. The values of COF were different on different surfaces, however, the COF values for each surface was highest for OsseoTi™. Table 1 summarizes the values of COF obtained for the different groups. Figure 1 shows an illustration of the test set up to conduct the COF testing. Figure 2 shows OsseoTi™ sample being tested against bovine cortical bone.

Conclusions: OsseoTi™ has high surface roughness and had significantly higher COF values on different surfaces. The sawbones blocks were flat as shown in Figure 1. However, the bone samples were not flat and the bone surface topology was preserved, which presented a challenge in stabilizing the samples over the surface of bone during testing. Further improvements are being implemented to the testing technique to increase the stability of the samples over the bone surfaces to obtain repeatable values over different shapes of porous metal samples. The work done in this research would assist in optimizing the properties of porous metal structures which would be used in future medical devices.

Table 1. Average COF for porous metal samples analyzed against different surfaces.

Sample	Bovine cortical bone	Swine cortical bone	20 pcf sawbone	40 pcf sawbone
OsseoTi™	0.78	1.33	1.94	1.19
Regenerex™	0.59	0.73	1.21	0.88
Trabecular Metal™	0.38	0.64	0.71	0.61

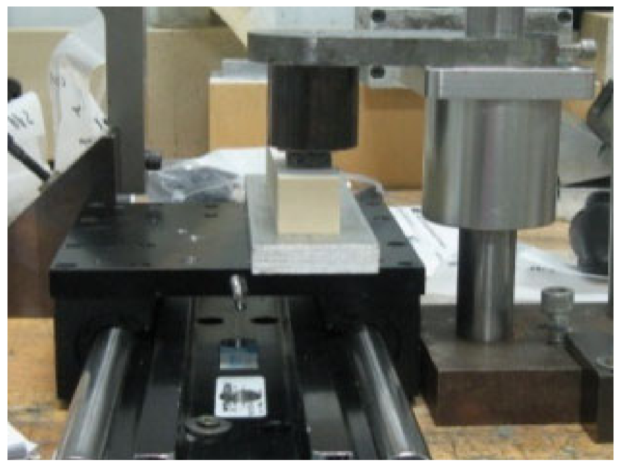

Fig. 1. Test set up for measuring the coefficient of friction of porous metal structures.

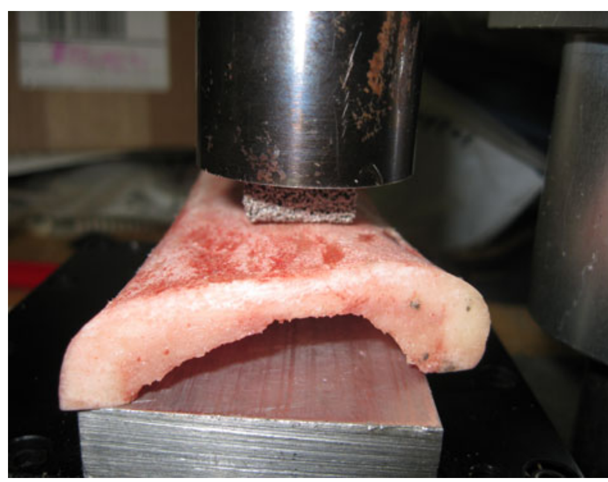
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Fig. 2. Test set up for measuring the coefficient of friction of OsseoTi™ against bovine cortical bone.