MINERAL CONTENT ANALYSIS OF POSTMORTEM RETRIEVED POROUS COATED TOTAL KNEE COMPONENTS

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**Introduction**: The mineral content in bone is a significant contributor to bone strength. To date, previous research on postmortem retrieved porous coated components has quantified bone ingrowth into the porous coated region and its relationship to the corresponding interface and host bone regions. In order to gain a further understanding of the skeletal attachment dynamics, it is also important to understand the mineral content levels of bone at the bone implant interface since previous studies of mineral content in bone have determined that there is a direct relationship to biomechanical properties and bone strength. However, these types of studies have not been conducted on the mineral content of human bone in postmortem retrieved total knee replacement (TKR) components. Backscattered Electron (BSE) imaging enables the quantification of mineral content of human bone at the implant interface in situ at high resolution.

A unique collection of 14 postmortem retrieved porous coated TKR components from previously clinically successful patients have been reported to have extensive bone ingrowth. These same specimens were used to measure the mineral content at the implant interface (periprosthetic region) and >3 mm away at the host bone region. The objective of this study was to compare the mineral content at these two regions with a hypothesis that the mineral content at the implant interface would be similar to the mineral content at the host bone region. This rationale was based on the assumption that the interface would have had adequate time, due to length of implantation period, to adapt mineral content levels equal to host bone. Another goal was to determine if there were different mineral content levels at the interface of three different porous coated implant sites (femur, patella, and tibia).

**Methods**: Appropriate Institutional Review Board (IRB) approval was obtained. The components were of the Natural Knee design with a commercially pure titanium porous coating. All surgeries were performed by one surgeon applying a layer of autograft bone chips at the interface of the components. The entire set of 14 patellas and tibias were analyzed, while only 12 femurs were analyzed due to processing complications caused by incomplete polymerization. The average age of the donors at death was 76±6 years (66 to 87 years) and included an all male population. The implants were in situ for 7±3 years. The modified HSS knee scores evaluated 3-7 months prior to death averaged 98 for the study. Digital BSE images taken at 200x magnification with a calibration frame averaging technique. Calibration standards consisting of whale tympanic bulla and deer antler carbon to correct for fluctuations of the microscope along with two bone standards from previously clinically successful patients were analyzed, while only 12 femurs were analyzed due to processing complications caused by incomplete polymerization. The average age of the donors at death was 76±6 years (66 to 87 years) and included an all male population. The implants were in situ for 7±3 years. The modified HSS knee scores evaluated 3-7 months prior to death averaged 98 for the study.

Backscattered Electron (BSE) imaging enables the quantification of mineral content of human bone at the implant interface. Lower mineral content at the porous coating interface may be a natural adaptation to assure durable skeletal attachment under cyclical ambulatory conditions. In addition, the difference in mineral content at the two regions could be due to the application of autograft bone chips at the time of implantation. Future studies would be required to understand the relationship between bone volume, fatigue properties, and mineral content for achieving durable skeletal attachment in porous coated implants.

**Results**: The periprosthetic region of the femur measured a WMGL of 110.1±8.8, which correlated to an ash percent of 63.6±1.7%. The host bone of the femur measured a WMGL of 121.2±8.4, which correlated to an ash percent of 65.8±1.7%. The periprosthetic region of the patella measured a WMGL of 97.4±9.3, which correlated to an ash percent of 64.7±1.7%. The host bone of the patella measured a WMGL of 108.4±9.0, which correlated to an ash percent of 66.7±1.7%. The periprosthetic region of the tibia measured a WMGL of 82.0±9.9, which correlated to an ash percent of 65.0±0.8%. Statistical analysis determined that there was a significant difference (p<0.01) between the interface mineral content when compared to the host bone mineral content for all three components (Figure 1).

**Discussion**: There was a lower mineral content (ash percent) at the implant interface when compared to the host bone in each component. Vose and Kubala found that even a small difference in mineral content can cause an exponential difference in mechanical strength. Thus, the lower mineral content found at the periprosthetic region in this study suggests that the bone biologically adapted to achieve mechanical and fatigue properties that may have made it advantageous at the site of the implant interface. Lower bone mineral content at the porous coating interface may be a natural adaptation to assure durable skeletal attachment under cyclical ambulatory conditions. In addition, the difference in mineral content at the two regions could be due to the application of autograft bone chips at the time of implantation.

**References**:

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