THE EFFECT OF REMOVING BLOOD AND BONE OIL ON THE MECHANICAL STRENGTH OF CEMENT-BONE INTERFACE

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Introduction:
Loosening is one of the major causes of late failures of total joint replacements. Almost all cases of loosening occur on the cement-bone interface. Therefore, loosening can be avoided by improving the mechanical strength of cement-bone interface.

We hypothesized that removal of blood and bone oil improves the mechanical strength of the cement-bone interface. In this study, using cancellous bone, we compared the mechanical shear strength of cement-bone interface with and without blood and bone oil.

Methods:
6 pairs of ox tibiae were used. Each proximal tibia was osteotomized 20mm below the medial plateau, and vertical holes (7.5 mm diameter) were drilled in the tibiae. Each cut surface was washed using pallsatile lavage to clean out bone debris.

Two cases of experiment were carried out to investigate each influence of blood and bone oil. To examine the influence of remaining blood, one side of the 3 pairs of tibiae was soaked in a fresh human blood to simulate bleeding from the bone (BLOOD+), and the other side was left as it is (BLOOD-). Likewise, to learn the effect of removing bone oil, one side of the 3 pairs tibiae was cleaned using 1 percent aqueous surfactant used as food additive (OIL-), and the other side saline solution (OIL+).

Doughy cement (Simplex P) was injected into each hole using a caliber syringe under pressure. Then, 3 cross sections of 10 mm thickness were sliced off from the proximal tibiae, and each cylindrical cement buried in the bone plates was pushed-out by Instron mechanical test machine. The maximum load at failure was converted to an interface shear stress (ISS). 103 and 117 pieces of cylindrical cement were pushed to test the effect of blood removal, as the groups of BLOOD+ and BLOOD-, respectively. Likewise, 139 and 121 pieces of cement were used to test the effect of oil removal using surfactant, as OIL- and OIL+.

Results:
The ISS (means ± 1 S.D.) of the result of with and without blood is shown in the Figure 1. The ISS of BLOOD+ and BLOOD- were 2.3(1.1) MPa and 2.7(1.3) MPa, respectively, so the ISS of BLOOD- shows an increase of 18 percent as compared with BLOOD+. Figure 2 shows the results of OIL+ and OIL-. The ISS of OIL+ was 2.6(1.5) MPa, and OIL- was 3.8(1.9), so the ISS of OIL- shows an increase of 46 percent as compared with OIL+. Statistically significant differences were found in the ISS between BLOOD+ and BLOOD- (p<0.01, Student's t-test), and OIL+ and OIL- (p<0.0001, Welch's t-test). Removal of blood
and bone oil obviously improved the ISS.

**Discussion and Conclusion:**

Removal of blood and bone oil remarkably increased the mechanical strength probably through the improvement of microlock between cement and bone by the removal of the interposing material. Some papers described that cleaning out blood and bone debris on the bone surface gives satisfactory strength. However, other authors suggest that bone oil membrane decreases the mechanical strength, more than other factors. One of the reasons for it will be that bone oil on the surface will not be removed completely, even by applying the palsatile lavage system using only saline solution.

Thus, we came to a conclusion that removal of blood and bone oil within the bone is essential to the improvement of the fixation, and that non-invasive technique to remove bone oil is needed.

Since it was food additive, we regarded the toxicity of the surfactant chosen in this study as not serious, but the safety must be ensured.

**References:**

3) G. C. Bannister, et al., Engineering in Medicine, pp131-133, 1988  

![Figure 1: Comparison of Interface Shear Stress with / without Blood. Means (±1S.D.) for Max Shear Stress. (*:significant difference at p<0.01, Student's t-test )](image)

![Figure 2: Comparison of Interface Shear Stress with / without Bone Oil. Means (±1S.D.)for Max Shear Stress. (**:significant difference at p<0.0001, Welch's t-test )](image)