HIGH PRESSURE PULSATILE LAVAGE IRRIGATION OF FRESH INTRAARTICULAR FRACTURES: EFFECTIVENESS AT REMOVING PARTICULATE MATTER FROM BONE

*Lee, E; **Dirschl, D; **Duff, G; **Dahners, L; **Edin, M; **Miclau, T
**University of California, San Francisco, San Francisco, CA. University of California, San Francisco, San Francisco General Hospital, 1001 Potrero Ave., Rm. 3A36, San Francisco, CA 94143, (415) 206-8812, Fax: (415) 647-3733, miclau@orthosurg.ucsf.edu

Introduction: High pressure pulsatile lavage irrigation is commonly used clinically to irrigate contaminated open fractures. Compared with bulb syringe irrigation, pulsatile lavage can deliver a high volume of irrigant over a short period of time. Pulsatile lavage is also thought to be extremely effective in removing particulate debris and bacteria from bone. However, recent studies have suggested that this method of irrigation may also increase the penetration of particulate matter into bone and intramedullary propagation of bacteria. The purpose of this study is to determine the ability of high-pressure pulsatile lavage and bulb syringe irrigation to remove particulate matter from bone and their effect on particulate penetration into bone.

Materials and Methods: Operative manipulation was performed on the left hind limbs of 20 adult New Zealand white rabbits immediately after euthanasia. Knee arthrotomy and osteotomy of the medial femoral condyle were accomplished according to the method described by Mitchell and four grams of particulate graphite (Fisher, Fair Lawn, NJ, USA) with a mean particle size of two micrometers were placed into the osteotomy site. The limbs were then divided into two equal groups. The ten specimens of the pulsatile lavage group (P) were irrigated with 1 L of normal saline using a commercially available pulsatile lavage system (Surgilav Plus, Stryker, Warsaw, IN, USA) held 15cm from the osteotomy site. This device delivered irrigant at a nozzle pressure of 480KPa. The ten specimens of the bulb syringe group (B) were irrigated with 1 L of normal saline delivered using a 250cc bulb syringe held 15cm from the osteotomy site. All fracture specimens then underwent stabilization with a single 2.7mm lag screw (Synthes, Paoli, PA, USA), followed by wound closure, immediate retrieval and histological evaluation.

All specimens were fixed in an ascending series of alcohol solutions for 3 days each, followed by immersion in 2 methylmethacrylate solutions for 3 days each. The undecalcified bone and cartilage was then sectioned coronally using the Leitz 1600 microtome (Leitz, Wetzler, Germany) and a representative section from the center of the femur was then hand-sanded to a micrometer confirmed thickness of 75-90 micrometers, stained with Giemsa, and mounted. A single blinded observer performed histological evaluation of all specimens using 40X light microscopy to quantify the number and distribution of graphite particles around the osteotomy site. In evaluating the specimens, it was noted that graphite particles were not present as individual 2 micrometer particles, but as aggregates. For purposes of data collection and analysis, these aggregates were grouped into three size ranges: small (<20 micrometers), medium (20-50 micrometers), and large (>50 micrometers).

The size and perpendicular distance from the osteotomy site of all aggregates observed in the central 8 calibrated fields at 40X (2.16mm) of each specimen were recorded to the nearest field (0.27mm). This allowed the mean maximum perpendicular distance from the osteotomy site, total number of aggregates within four calibrated fields (1.08mm) immediately adjacent to the osteotomy site, and total number of aggregates in the area surveyed to be recorded easily. Statistical analysis comparing the bulb syringe and pulsatile lavage groups were then performed using an equal variance, two-sample t-test and non-parametric Mann-Whitney test.

Results: The mean maximum perpendicular distance of graphite aggregates of all sizes from the osteotomy site was 12.5mm (+/- S.D. 2.0) in the bulb syringe group and 12.4mm (+/- S.D. 2.5) in the pulsatile lavage group (p>0.5). The mean number of aggregates within four 40X fields (1.08mm) of the osteotomy site was 21.8 (+/- S.D. 27.5) in the bulb syringe group and 21.9 (+/- S.D. 22.0) in the pulsatile lavage group (p>0.5). The mean total number of aggregates in the area surveyed was 137.5 (+/- S.D. 113.6) in the bulb syringe group and 129.4 (+/- S.D. 79.6) in the pulsatile lavage group (p<0.5). In addition, analysis comparing these two methods of irrigation was performed after controlling for aggregate size (small, medium, and large). This also revealed no significant difference between pulsatile lavage and bulb syringe groups for any of the above parameters.

Discussion: Based on the results of this study, high-pressure pulsatile lavage and bulb syringe irrigation appear equally effective in removing particulate matter from bone. Furthermore, high-pressure pulsatile lavage irrigation does not appear to drive particulate matter farther into bone than bulb syringe irrigation in fresh intra-articular fractures. No statistically significant difference was observed between these two methods of irrigation with regards to mean maximum perpendicular distance of graphite aggregates from the osteotomy site, mean number of aggregates immediately adjacent to the osteotomy site, or mean total number of aggregates in the area surveyed regardless of aggregate size. This suggests that pulsatile lavage and bulb syringe irrigation are equally effective at removing particulate matter from bone, a finding which contrasts with previous soft tissue studies demonstrating the increased effectiveness of pulsatile lavage over bulb syringe irrigation in the removal of particulate matter in that setting.

**University of North Carolina at Chapel Hill, Chapel Hill, NC