IMPROVEMENT OF CEMENT MANTLE THICKNESS WITH PRESSURIZED CARBON DIOXIDE LAVAGE

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Introduction: The long-term success of cemented total knee arthroplasty is largely dependent on the mechanical integrity of the bone-cement interface. For cemented knee implants, fixation strength depends on the depth of cement penetration as well as the cleanliness and dryness of the resected bone surface at the time of cementation.[1-4] Cementation techniques also play a significant role in the incidence of radiolucent lines at the bone-cement interface, which can be an indicator of aseptic loosening.[2,5] Cement mantle integrity is also thought to provide resistance to osteolysis after knee arthroplasty.[6]

The objective of this study was to examine the effect of a carbon dioxide gas lavage technique[7] on the depth of cement penetration in bone of the distal femur. This study evaluated the impact of using pressurized carbon dioxide lavage after pulsatile saline lavage on thickness of the bone-cement mantle.

Methods: The discarded bone specimens from sixteen anterior femur resections performed during total knee arthroplasty were used for analysis. Both the medial and lateral halves of each bone specimen were irrigated with pulsatile saline lavage and suction using standard methods. Half of each specimen was further cleansed with a pressurized spray of medical-grade carbon dioxide gas (CarboJet, Kinamed Inc, Camarillo, CA, USA). High viscosity bone cement was then applied to each half using thumb pressure. After the cement had cured, the specimens were placed on a digital x-ray cassette which was positioned 90º to the specimen axis for radiographic evaluation of cement penetration depth (Figure 1). The images were developed and printed on photographic paper at known magnification. The maximum cement mantle thickness in each side of each specimen was then measured and compared.

Results: The specimen sides treated with carbon dioxide lavage had an average cement mantle thickness of 1.82 mm ± 0.61mm compared to a thickness of 1.35mm ± 0.42mm for the sides in which only pulsed lavage was used (Table 1). The use of carbon dioxide lavage resulted in a 35% increase in cement penetration depth ($p = 0.02$).

Specimen No.	Cement Penetration Depth after Pulsatile Saline and Carbon Dioxide Lavage (mm)	Cement Penetration Depth after Pulsatile Saline Lavage only (mm)
1	1.89	1.63
2	1.89	1.38
3	2.65	1.89
4	2.40	1.63
5	1.63	1.17
6	2.65	2.14
7	2.40	1.63
8	1.63	1.12
9	1.63	0.87
10	2.40	1.63
11	2.14	1.63
12	0.87	0.87
13	1.38	1.12
14	0.87	0.87
15	1.89	1.38
16	0.87	0.62

Table 1. Depth of cement penetration for each specimen treated with pulsatile saline plus carbon dioxide lavage or pulsatile saline lavage only. The sides treated with carbon dioxide lavage had an average cement mantle thickness of 1.82 mm ± 0.61mm compared to 1.35mm ± 0.42mm for the sides in which only pulsed lavage was used (p = 0.02).

Discussion: The problem of aseptic loosening after cemented joint arthroplasty has spurred the evolution of modern cementing techniques, which have been developed to improve implant longevity by increasing cement penetration into the interstices of cancellous bone and by achieving a clean, dry interface between cement and bone.[1-5,8] While the goals of an optimal cementing technique are well-recognized, there are few reports in the literature that describe surgical instruments which are designed to simultaneously achieve deeper cement penetration and a clean, dry bone interface.

In this study, the addition of carbon dioxide lavage after pulsed saline irrigation and suction allowed for significantly greater cement penetration into cancellous bone. This improvement is thought to be due to the displacement and removal of residual fluid and fatty material that remains in cancellous bone after conventional pulsed saline irrigation and suction.

It is believed that the absence of residual fluid and fatty material results in lower hydrostatic pressure within the cancellous bone during cementation that would otherwise resist the penetration of cement and get pushed deeper into the bone. Improved cement mantle thickness in joint arthroplasty through the use of carbon dioxide lavage may enhance bone-cement interface strength and implant longevity.

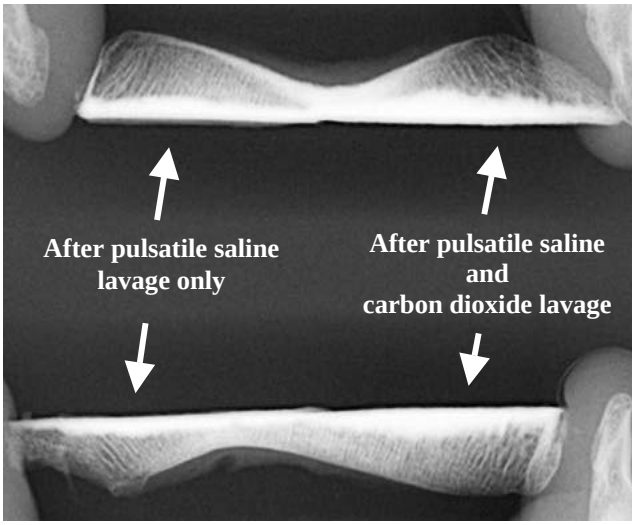

Figure 1. Radiograph depicting cement penetration into medial and lateral halves of bone specimens taken from discarded anterior femur resection during total knee arthroplasty.

References:

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