Evaluation of a New Power-Operated PMMA Vacuum Mixing and Delivery System for Cemented Femoral Stem Insertion

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Abstract

Variations exist in the manual preparation and delivery of cement during primary total hip arthroplasty. The incorporation of a power source may standardize cement mantle manufacturing. This study prospectively compared the use of a new power-operated polymethylmethacrylate vacuum mixing and delivery system to a commonly used manually powered industry standard. The study did not reveal a significant difference in the quality of cement mantle grades when comparing the use of this power-operated system to an industry standard manual system. However, the benefit of the new preparation and delivery system may be in consistent porosity reduction and not in the improvement of cement mantle grading.

The routine use of a manually powered polymethylmethacrylate (PMMA) vacuum mixing and delivery system has allowed orthopedic surgeons to use third-generation cement technique at stem insertion. The technique for cement preparation has undergone several generations of development. First-generation technique included finger packing, no canal preparation, no cement plug, and no cement pressurization. Second-generation technique evolved to include canal preparation with pulsatile lavage and retrograde filling of the femoral canal with a cement gun and cement pressurization against a restrictor. A third-generation cement technique includes porosity reduction via vacuum mixing and centrifugation.1-7 Despite this technological advancement, variations in the preparation and delivery of PMMA cement still exist; standardization of intraoperative cement mantle manufacturing has not yet been achieved.

A number of studies have correlated cement technique with the quality of radiographic cement mantle grading.8-10 A previous comparison of third-generation techniques using readily available vacuum mixers has been reported6; however, standardization of cement mixing and delivery into the femoral canal remains operator-dependent.

This study prospectively compared cement mantle grades resulting from the use of a new power-operated PMMA vacuum mixing and delivery system to a commonly used manually powered industry standard.

MATERIALS AND METHODS:

Thirty consecutive patients undergoing primary total hip arthroplasty with cemented femoral stems (Natural; Centerpulse Orthopaedics, Austin, Tex) were randomized by operating room. Fifteen consecutive patients in group 1 underwent stem insertion using a new power-operated PMMA vacuum mixing and delivery system (Twistor; Immedica, Chatham, NJ), and 15 consecutive patients in group 2 underwent stem insertion using a manually powered vacuum mixing and delivery system (Advanced Cement Mixing System; Stryker, Allendale, NJ). Manufacturer’s guidelines for each system were followed while using Simplex-P PMMA cement (Howmedica, Allendale, NJ).

The power-operated PMMA system uses a readily available power source (Stryker 2000 reamer; Stryker, Allendale, NJ) to assist in PMMA mechanical preparation and delivery. The power source allows for a standard mixing rate of 1 Hz for 30 seconds under vacuum, and is also used for retrograde canal filling and cement mantle pressurization at 40 psi for 5 seconds. The manually powered system uses a hand-mixing tower in addition to a vacuum
porosity reduction cannister, which converts into a hand-pumped delivery cement gun.

Two blinded reviewers using routine radiographs from first postoperative follow-up performed independent grading of the cement mantles. The quality of the cement mantle has been described by Barrack et al. and Harris using a scale of A to D. Complete filling of the medullary cavity, a so-called “white-out” at the cement-bone interface, was graded A. Slight radiolucency of the cement-bone interface was defined as B. Radiolucency involving 50%-99% of the cement-bone interface was graded C1. Grade C2 was given to a defect where the tip of the stem abuts the cortex with no intervening cement. Radiolucency of the cement-bone interface of 100% in any projection or failure to fill the canal with cement such that the tip of the stem was not covered was classified D.

Scores of 5, 4, 3, 2, and 1 were assigned to cement mantle grades of A, B, C1, C2, and D, respectively, to obtain a numeric average (Table). The Figure illustrates cement grading A and C1, respectively. Average grades were assigned to each group.

RESULTS

Group 1 received an average grade of 4.06. Group 2 received an average grade of 4.03. No grade D mantles were assigned in either group. No statistical difference was found using Student’s t-test for statistical analysis (P<.05).

DISCUSSION

The introduction of third-generation cement technique improved the performance of PMMA for femoral stem fixation by decreasing cement porosity at retrograde canal filling and pressurization, but variations continue to exist in the manual preparation and delivery of cement. This study did not reveal a significant difference in the quality of cement mantle grades when comparing the use of this power-operated system to an industry standard manual system.

The future of PMMA cement preparation and delivery may include the use of a standard power source. The benefit of preparation and delivery standardization may be in consistent porosity reduction and not in the improvement of cement mantle grading. Further studies need to be performed to assess this hypothesis.

REFERENCES


<table>
<thead>
<tr>
<th>Grade</th>
<th>Cement-Bone Interface Correspondence</th>
<th>Numerical Correspondence</th>
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<tbody>
<tr>
<td>A</td>
<td>Complete filling of the medullary cavity, “white-out”</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>Slight radiolucency &lt;50%</td>
<td>2</td>
</tr>
<tr>
<td>C1</td>
<td>Radiolucency involving 50%-99%</td>
<td>3</td>
</tr>
<tr>
<td>C2</td>
<td>Tip of prosthesis abutting bone with no intervening cement</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>Radiolucency of 100%, failure to fill canal with cement</td>
<td>5</td>
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