The effect of laminar air-flow on the results of Austin-Moore hemiarthroplasty

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Introduction

In 1990, an estimated 1.3 million hip fractures occurred worldwide, a figure which is expected to double by 2025 and increase to 4.5 million by 2050. Approximately, half of these fractures will be...
intracapsular. The average age of these patients is 80 years and 75% are female. The preferred management is internal fixation or endoprosthesis. Three different types of arthroplasty are available: a unipolar hemiarthroplasty, a bipolar hemiarthroplasty or a total hip replacement.

Aim

This study is a second cycle audit following our previous publication in Injury. In our previous study (88 cases), the re-operation rate within 1 year following Austin-Moore hemiarthroplasty was 11.4% (10/88 cases), with 4.5% (4/88 cases) secondary to infection. This rate was high compared to published series, with a poor success rate in retaining the prosthesis when compared to the literature. All the cases of Austin-Moore hemiarthroplasty in our previous study were performed in the non-laminar air-flow theatre using cotton drapes and surgical gowns and peri-operative intravenous cefuroxime.

Two measures were introduced as a result of the first audit findings:

1. water impervious gowns and drapes;
2. laminar air-flow theatre whenever available.

This second cycle audit was carried out to evaluate their impact on re-operation rate within the first year following Austin-Moore hemiarthroplasty.

Materials and methods

A consecutive cohort of patients who underwent Austin-Moore hemiarthroplasty performed at our hospital between August 2000 and July 2004 were included in the study. The study was conducted by reviewing case notes and radiographs, and the following data was collected: age, sex and classification of the fracture, date of operation, surgical approach, indication and date of re-operation. The minimum follow-up period was 1 year and maximum was 5 years. Of the total of 435 patients, 212 were operated in laminar air-flow theatres and 223 were operated in non-laminar air-flow theatres (where laminar air-flow theatres were not available for logistical reasons). All the cases were performed by middle grades using the lateral Hardinge approach. Peri-operative antibiotics (three doses of intravenous cefuroxime, 1.5 g at induction and two post-operative doses of 750 mg at 8 and 16 h post-operatively) and water-impervious surgical gowns and drapes were used in all cases.

Results

The two groups of patients showed statistically similar age and sex distribution using the two-sample t-test. There were 337 females and 96 males. The mean age of the male group was 84.03, S.D. 7.80 and S.E. ± mean 0.80. The female mean age was 84.98, S.D. 7.73 and S.E. ± mean 0.42. The mean age of the patients for the non-laminar air-flow group was 84.76, S.D. 7.79 and S.E. ± mean 0.52 and that for the laminar air-flow group were 84.03, S.D. 7.72 and S.E. ± mean 0.53.

The overall rate of re-operation for all indications within 1-year post hemiarthroplasty was 3.7% (16/435), compared to 11.4% (10/88) in the first audit. The re-operation rate for all indications in the first year after hemiarthroplasty was 5.8% (13/223) in the non-laminar air-flow group and 1.4% (3/212) in the laminar air-flow group (Table 1). The rate of re-operation for infection was 9 out of the 223 cases (4%) in the non-laminar air-flow group, whereas that for the laminar air-flow group was nil out of 212 cases (0%) (Table 2).

Analysis of results

The data was analysed using the Minitab Statistics Software for Windows. The Fisher exact test and Wilcoxon test were used to evaluate the difference in outcomes between the three groups, these being: the previous study of 88 cases (cotton gowns and drapes and conventional theatres), and the two cohorts of the present study (i.e. the laminar air-flow group and the non-laminar air-flow group).

The overall re-operation rate: there was no statistically significant difference caused by the introduction of water impervious gowns and drapes (p-value 0.150), whereas the use of laminar air-flow theatres lead to a statistically significant drop (p-value of 0.0285) in the overall re-operation rate within the first year after Austin-Moore hemiarthroplasty.

The comparison of the rates of re-operation for infection of the first cycle audit results (non-laminar air-flow theatre and cotton gowns and drapes) to the results of the non-laminar air-flow group of the second cycle audit (non-laminar air-flow theatre with water impervious gowns and drapes) showed that the introduction of water impervious gowns and drapes did not lead to a statistically significant difference in the outcome (p-value of 0.764). However, the transition to laminar air-flow equipped theatres lead to a statistically significant reduction in the re-operation rate for infection (p-value of 0.00368).

The difference in re-operation rate for other indications (aseptic loosening and dislocation) were
Discussion

Early revision surgery after failure of a procedure for hip fracture is associated with a poor prognosis, an increase in mortality, a decrease in the number of patients able to return to their original residence and a threefold rise in the financial cost of treatment.9,17

Nelson showed that in a non-laminar air-flow theatre the average count of airborne bacteria was 5.4 per cubic foot, compared to 0.45 per cubic foot in laminar air-flow theatres. The wound contamination rates were reduced by at least 80% when laminar air-flow was used.1,4,6,13,16

In 1974, the Medical Research Council of Great Britain initiated a prospective study of the use of laminar air-flow theatres compared to conventional theatres for total joint arthroplasty surgery. The results show an incidence of 1.5% of deep wound infection in conventional rooms as opposed to 0.6% for clean-air rooms.10 To our knowledge, there is no clear reference in the literature to the impact of laminar air-flow on outcomes of hemiarthroplasty for hip fractures.

Our present study includes two groups of patients who showed no statistical variation in age or sex distribution. The distribution of the patients into the two groups was due to limited availability of laminar air-flow theatre space. Our re-operation rates within 1-year post Austin-Moore hemiarthroplasty were comparable to those published by Palmer et al. (4.8%).19

The survival of Austin-Moore hemiarthroplasty, considering re-operation as the definitive end point, was found to be significantly lower in the non-laminar air-flow theatre group (Fig. 1).

The higher overall re-operation rate in the non-laminar air-flow theatre group was found to be solely attributable to the higher infection rate in this group (Table 1).

### Table 1  Indications for re-operation within 1 year after Austin-Moore hemiarthroplasty

<table>
<thead>
<tr>
<th></th>
<th>First cycle</th>
<th>Second cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theatre type</td>
<td>Non-laminar</td>
<td>Non-laminar</td>
</tr>
<tr>
<td>Number of patients</td>
<td>88 cases</td>
<td>223 cases</td>
</tr>
<tr>
<td>Infection</td>
<td>4.5% (4/88)</td>
<td>4% (9/223)</td>
</tr>
<tr>
<td>Aseptic loosening</td>
<td>3.4% (3/88)</td>
<td>0.9% (2/223)</td>
</tr>
<tr>
<td>Dislocation</td>
<td>3.4% (3/88)</td>
<td>0.9% (2/223)</td>
</tr>
<tr>
<td>Overall re-operation rate</td>
<td>11.4% (10/88)</td>
<td>5.8% (13/223)</td>
</tr>
</tbody>
</table>

### Table 2  Bacteriology results based on tissue/deep swab specimen obtained at time of re-operation

<table>
<thead>
<tr>
<th>Bacteriology</th>
<th>Number of cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRSA</td>
<td>1</td>
</tr>
<tr>
<td>MRSA plus Klebsiella</td>
<td>1</td>
</tr>
<tr>
<td>Coagulase negative Staph</td>
<td>6</td>
</tr>
<tr>
<td>No growth</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 3  Re-operations performed following Austin-Moore hemiarthroplasty

<table>
<thead>
<tr>
<th>Complication</th>
<th>Procedure</th>
<th>Conventional theatre</th>
<th>Laminar air-flow theatre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>Excision arthroplasty</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Single stage revision to THR</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Aseptic loosening</td>
<td>Revision to THR</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Dislocation</td>
<td>Open reduction</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Closed reduction</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Although studies have shown that water impermeable fabrics are better bacterial barriers than cotton drapes and gowns, the introduction of water-impermeable drapes and gowns did not seem to make a statistically significant improvement in the results of Austin-Moore hemiarthroplasty in our study (Table 3).

Conclusion

The rate of re-operation for all indications within the first year in the non-laminar air-flow theatre group was more than four times greater than in the laminar air-flow group. We recommend that Austin-Moore hemiarthroplasty procedures should be performed in laminar air-flow equipped theatres.

Conflict of interest

None.

References
