Haemodynamic Changes in Patients undergoing Total Joint Replacements
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Citation

Abstract
We present our analysis of the data collected for total joint replacement (TJRs) conducted from July 2002 to December 2003. Analysis of demographic data, ASA grading, anaesthesia technique, surgical diagnosis, vital parameters, ST segment analysis and dysrhythmia if any, especially peri-prosthesis insertion was done. Student ‘t’ test was applied to analyze vital parameters.

There was no intraoperative mortality or in immediate post-operative period. In the cemented hip replacements there was no statistical significance in pulse except at 2 minute after insertion of first component and 10 minutes after second component as compared to their respective pre-insertion values. In TKR statistically significant rise in MAP was noted after insertion of components as compared to their respective pre-insertion values. Statistically significant rise in CVP was noted in cemented THR at 6 minutes and 10 minutes after insertion of first component as compared to their pre-insertion values. CVP in cemented THR was significantly higher at 6 minutes after insertion of 1st component and 4, 6 and 10 minutes after insertion of second component.

Significant haemodynamic changes thought to be associated with insertion of implants is independent of age, ASA grading, cemented/uncemented provided patients are well optimized pre and intra-operatively and CVP is maintained.

AIM
To analyse patients who underwent total joint replacements in our institute over the last one and half year (from July 2002 to December 2003). The following parameters were analysed: demographic data, ASA grading, anaesthesia technique, duration, surgical diagnosis, haemodynamic parameters (pulse, MAP, SpO₂, EtCO₂, CVP) especially around insertion of prosthesis.

INTRODUCTION
It is thought that Bone Cement Implantation Syndrome (BCIS) is associated with insertion of cemented implants. In humans, plasma level of monomer is found to be low to exclusively contribute to it. It is hence usually inferred that it is the intramedullary hypertension after insertion of prosthesis, which causes the syndrome and is characterized by hypotension, hypoxaemia, dysrhythmia and sometimes can even be life threatening. Cementing leads to myocardial depression and intrapulmonary deposition of platelet and fibrin aggregates. It is also believed that if patients are well hydrated and haemodynamically stable, the incidence of this syndrome is least.

After obtaining appropriate permission, 204 (of a total of 253) patients undergoing TJRs were studied. We could not obtain data of remaining patients.

Out of 215 (204 patients) arthroplasties, 11 patients underwent bilateral replacements in one sitting (5 cemented THR, 1 uncemented THR and 5 TKR). There were 93 (88 patients) cemented THR, 43 (42 patients) uncemented THR, 67 (72 patients) TKR and 1 TER. Cemented prosthesis was used for TKR and TER.

MATERIALS AND METHODS
Decision of surgery and type of prosthesis to be used was taken by the operating orthopaedic surgeon. All the patients were thoroughly evaluated and optimized preoperatively and were explained the anaesthesia technique. After confirming their consent and starvation status, peripheral venous cannulation was done. External Jugular vein (EJV) was cannulated in all patients for CVP monitoring, which was removed after the surgery was over. TER was done under brachial plexus block (BB). Combined Spinal Epidural (CSE) technique was planned for all patients. After
appropriate positioning, O2 (3L/min) was given by mask to
all patients. EtCO2 tubing was attached to the mask, which
was used to monitor it. However for some reason if CSE was
not possible, GA was given. Pulse, MAP (calculated by SBP
and DBP), SpO2, EtCO2, CVP, ST segment analysis and
dysrhythmia were monitored at various intervals viz;
preoperatively, preinduction, post induction, post
positioning, post incision, prior to insertion of first part of
implant, during insertion, 2, 4, 6, 10 minutes after its
insertion, prior to insertion of second part of implant, during
insertion, 2, 4, 6, 10 minutes after insertion and
postoperatively. Prior to insertion of cemented prosthesis Inj.
ydrocortisone 100mg and anti-histaminic (2ml/45mg
pheniramine maleate, not in ASA III and > 70 years age)
was given. Postoperatively analgesia was given by either
intermittent bolus or infusion using disposable elastomeric
pumps. Student ‘t’ test was applied to analyze vital
parameters. Paired ‘t’ test was used to analyze the parameters
after insertion of the components with respect to their
respective preinsertion values while unpaired ‘t’ test was
used to compare the two hip replacement groups.

p < 0.05 was considered as significant, ** p < 0.01 as very
significant and *** p < 0.001 as highly significant.

RESULTS

Figure 1

Table 1:

<table>
<thead>
<tr>
<th>Total</th>
<th>Hips (%</th>
<th>Hips (%)</th>
<th>Knee (%)</th>
<th>TER (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>43</td>
<td>72</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

As a rule arthroplasty was done unilaterally. Majority of
patients belonged to ASA I or II. Only 8 out of 204 patients
belonged to ASA III. CSE was the preferred anaesthesia
technique.

More males underwent THR as compared to females who
underwent more TKR. Mean age of the patients undergoing
TKR was higher as compared to those undergoing THR
(uncemented less than cemented). In the series, the youngest
patient was 20 years old male while the eldest was 87 years
old female.

Figure 2

Table 2: Surgical Diagnosis

<table>
<thead>
<tr>
<th># TC</th>
<th>AVN</th>
<th>HAPO</th>
<th>OA</th>
<th>RA</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>16</td>
<td>18</td>
<td>15</td>
<td>11</td>
<td>17</td>
</tr>
</tbody>
</table>

As seen # transcervical (TC) femur and avascular necrosis
(AVN) were the predominant reason for THR while osteo
arthritis (OA) was the main indication for TKR. Rheumatoid
Arthritis (RA) was the indication for TER. There was no
intraoperative mortality or in immediate post-operative
period.

Figure 3

Table 3: Cemented THR (HIPC)

It can be seen that there was not much change in vital
parameters. Pulse remained more or less consistent around
80 bpm. In the cemented hip replacements there was no
statistical significance except at 2 minute after insertion of
first component and 10 minutes after second component as
compared to their respective pre-insertion values. MAP,
SpO2 and EtCO2 showed minimal changes around prosthesis
insertion, which were not statistically significant. With
respect to CVP, 6 minutes and 10 minutes after insertion of
first component there was statistically significant rise as compared to the respective values prior to insertion.

**Figure 4**

**Table 4: Uncemented THR (HIPUC)**

<table>
<thead>
<tr>
<th></th>
<th>Mean ± S.D.</th>
<th>Pulse</th>
<th>MAP</th>
<th>SpO2</th>
<th>ETCO2</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preop</td>
<td>85.9 ± 17.15</td>
<td>96.5 ± 0.99</td>
<td>99 ± 1.20</td>
<td>22.69 ± 5.07</td>
<td>3.79 ± 1.39</td>
<td></td>
</tr>
<tr>
<td>Preinduction</td>
<td>83.1 ± 19.80</td>
<td>94.0 ± 10.34</td>
<td>99 ± 0.72</td>
<td>22.94 ± 5.31</td>
<td>3.56 ± 1.59</td>
<td></td>
</tr>
<tr>
<td>Postinduction</td>
<td>85.74 ± 19.12</td>
<td>88.07 ± 9.81</td>
<td>99.20 ± 0.58</td>
<td>22.37 ± 4.80</td>
<td>3.49 ± 1.33</td>
<td></td>
</tr>
<tr>
<td>Postposition</td>
<td>81.30 ± 18.14</td>
<td>85.69 ± 9.55</td>
<td>99.10 ± 0.93</td>
<td>22.23 ± 4.70</td>
<td>3.74 ± 1.50</td>
<td></td>
</tr>
<tr>
<td>Post incision</td>
<td>81.26 ± 18.14</td>
<td>82.47 ± 8.62</td>
<td>99.20 ± 0.82</td>
<td>21.68 ± 4.80</td>
<td>3.77 ± 1.43</td>
<td></td>
</tr>
<tr>
<td>Prior 1st</td>
<td>85.88 ± 16.87</td>
<td>94.02 ± 0.86</td>
<td>99.20 ± 0.36</td>
<td>21.63 ± 4.67</td>
<td>3.87 ± 1.64</td>
<td></td>
</tr>
<tr>
<td>1st insertion</td>
<td>86.54 ± 16.76</td>
<td>93.72 ± 0.93</td>
<td>99.10 ± 1.09</td>
<td>21.41 ± 4.69</td>
<td>3.87 ± 1.46</td>
<td></td>
</tr>
<tr>
<td>1st 2 min</td>
<td>86.88 ± 16.54</td>
<td>94.02 ± 0.75</td>
<td>99.26 ± 0.00</td>
<td>21.70 ± 5.03</td>
<td>3.70 ± 1.49</td>
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</tr>
<tr>
<td>1st 4 min</td>
<td>85.97 ± 16.17</td>
<td>93.33 ± 0.95</td>
<td>98.71 ± 1.15</td>
<td>21.70 ± 5.74</td>
<td>3.58 ± 1.50</td>
<td></td>
</tr>
<tr>
<td>1st 6 min</td>
<td>84.88 ± 16.91</td>
<td>93.17 ± 0.97</td>
<td>99.35 ± 0.93</td>
<td>21.69 ± 5.19</td>
<td>3.54 ± 1.49</td>
<td></td>
</tr>
<tr>
<td>1st 10 min</td>
<td>84.70 ± 15.48</td>
<td>94.47 ± 0.80</td>
<td>99.40 ± 0.79</td>
<td>21.95 ± 5.05</td>
<td>3.72 ± 1.50</td>
<td></td>
</tr>
<tr>
<td>Prior 2nd</td>
<td>85.92 ± 15.76</td>
<td>94.38 ± 0.92</td>
<td>99.20 ± 0.24</td>
<td>21.04 ± 4.69</td>
<td>3.77 ± 1.49</td>
<td></td>
</tr>
<tr>
<td>2nd insertion</td>
<td>85.74 ± 14.97</td>
<td>89.08 ± 0.85</td>
<td>99.33 ± 0.68</td>
<td>22.12 ± 5.26</td>
<td>3.56 ± 1.52</td>
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</tr>
<tr>
<td>2nd 2 min</td>
<td>85.92 ± 15.61</td>
<td>92.86 ± 0.70</td>
<td>99.40 ± 0.59</td>
<td>21.94 ± 5.10</td>
<td>3.77 ± 1.32</td>
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</tr>
<tr>
<td>2nd 4 min</td>
<td>85.86 ± 17.05</td>
<td>94.42 ± 0.81</td>
<td>99.44 ± 0.07</td>
<td>22.03 ± 4.59</td>
<td>3.85 ± 1.54</td>
<td></td>
</tr>
<tr>
<td>2nd 6 min</td>
<td>86.82 ± 15.86</td>
<td>94.93 ± 0.84</td>
<td>99.02 ± 1.70</td>
<td>22.71 ± 5.07</td>
<td>3.58 ± 1.44</td>
<td></td>
</tr>
<tr>
<td>2nd 10 min</td>
<td>83.98 ± 14.92</td>
<td>85.21 ± 1.15</td>
<td>99.49 ± 0.58</td>
<td>21.63 ± 5.21</td>
<td>3.65 ± 1.33</td>
<td></td>
</tr>
<tr>
<td>Postop</td>
<td>85.26 ± 16.55</td>
<td>86.95 ± 7.97</td>
<td>99.47 ± 0.83</td>
<td>22.65 ± 5.34</td>
<td>3.72 ± 1.28</td>
<td></td>
</tr>
</tbody>
</table>

As seen there was no statistically significant change in any vital parameters around prosthesis insertion in uncemented THR.

**Figure 5**

**Table 5: TKR**

<table>
<thead>
<tr>
<th></th>
<th>Mean ± S.D.</th>
<th>Pulse</th>
<th>MAP</th>
<th>SpO2</th>
<th>ETCO2</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preop</td>
<td>70.68 ± 10.00</td>
<td>99.06 ± 9.63</td>
<td>99.02 ± 0.10</td>
<td>23.34 ± 4.05</td>
<td>3.64 ± 1.40</td>
<td></td>
</tr>
<tr>
<td>Preinduction</td>
<td>81.91 ± 15.59</td>
<td>95.86 ± 8.94</td>
<td>98.71 ± 1.07</td>
<td>23.75 ± 3.91</td>
<td>3.61 ± 1.54</td>
<td></td>
</tr>
<tr>
<td>Postposition</td>
<td>80.66 ± 15.05</td>
<td>87.65 ± 10.37</td>
<td>99.23 ± 4.29</td>
<td>23.23 ± 4.17</td>
<td>3.58 ± 1.58</td>
<td></td>
</tr>
<tr>
<td>Post incision</td>
<td>76.18 ± 16.75</td>
<td>87.34 ± 11.36</td>
<td>99.27 ± 4.84</td>
<td>23.49 ± 4.41</td>
<td>3.27 ± 1.55</td>
<td></td>
</tr>
<tr>
<td>Prior 1st</td>
<td>77.81 ± 13.31</td>
<td>80.73 ± 10.86</td>
<td>99.22 ± 4.78</td>
<td>22.89 ± 3.96</td>
<td>4.23 ± 1.62</td>
<td></td>
</tr>
<tr>
<td>1st insertion</td>
<td>70.05 ± 15.77</td>
<td>92.59 ± 11.20</td>
<td>99.13 ± 3.98</td>
<td>23.60 ± 4.43</td>
<td>1.79 ± 1.79</td>
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<tr>
<td>1st 2 min</td>
<td>70.75 ± 16.64</td>
<td>93.46 ± 11.94</td>
<td>99.08 ± 3.13</td>
<td>23.87 ± 4.36</td>
<td>1.51 ± 1.79</td>
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</tr>
<tr>
<td>1st 4 min</td>
<td>70.68 ± 15.97</td>
<td>93.51 ± 12.85</td>
<td>99.04 ± 3.96</td>
<td>22.89 ± 3.38</td>
<td>1.59 ± 1.58</td>
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<tr>
<td>1st 6 min</td>
<td>76.97 ± 15.21</td>
<td>93.38 ± 11.41</td>
<td>99.10 ± 2.48</td>
<td>22.65 ± 4.42</td>
<td>1.54 ± 1.58</td>
<td></td>
</tr>
<tr>
<td>1st 10 min</td>
<td>72.56 ± 16.13</td>
<td>93.93 ± 11.63</td>
<td>99.12 ± 2.56</td>
<td>22.75 ± 4.63</td>
<td>1.61 ± 1.63</td>
<td></td>
</tr>
<tr>
<td>Prior 2nd</td>
<td>70.20 ± 15.07</td>
<td>93.30 ± 11.62</td>
<td>99.05 ± 3.69</td>
<td>23.62 ± 4.35</td>
<td>1.81 ± 1.81</td>
<td></td>
</tr>
<tr>
<td>2nd 2 min</td>
<td>70.70 ± 15.77</td>
<td>94.43 ± 11.94</td>
<td>99.10 ± 3.98</td>
<td>23.60 ± 4.25</td>
<td>1.58 ± 1.57</td>
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</tr>
<tr>
<td>2nd 4 min</td>
<td>72.53 ± 16.60</td>
<td>94.57 ± 12.13</td>
<td>99.03 ± 3.48</td>
<td>23.18 ± 4.27</td>
<td>1.44 ± 1.44</td>
<td></td>
</tr>
<tr>
<td>2nd 6 min</td>
<td>76.76 ± 15.55</td>
<td>95.07 ± 11.57</td>
<td>99.31 ± 3.56</td>
<td>23.81 ± 4.42</td>
<td>1.41 ± 1.41</td>
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<tr>
<td>2nd 10 min</td>
<td>76.74 ± 17.62</td>
<td>94.62 ± 10.87</td>
<td>99.30 ± 3.35</td>
<td>23.35 ± 4.42</td>
<td>1.71 ± 1.71</td>
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</tr>
<tr>
<td>Postop</td>
<td>76.94 ± 15.86</td>
<td>93.03 ± 8.98</td>
<td>99.12 ± 2.94</td>
<td>24.91 ± 3.22</td>
<td>1.58 ± 1.58</td>
<td></td>
</tr>
</tbody>
</table>

* p ≤ 0.05 was considered as significant
** p ≤ 0.01 as very significant
*** p ≤ 0.001 as highly significant.

MAP showed statistically significant rise at 2 minutes, 4 minutes, 6 minutes and 10 minutes after insertion of first component as compared to their respective preinsertion values. After insertion of second component significance persisted up to 6 minutes. Other vital parameters did not show any statistically significant change around prosthesis insertion.
While comparing the THR there was no significant change in haemodynamic parameters except for CVP. In cemented THR it was significantly more at 6 minutes after insertion of 1st component and 4, 6 and 10 minutes after insertion of second component as compared to uncemented THR.

**DISCUSSION**

Bone cement implantation syndrome is a known entity. This is usually characterized by hypotension, hypoxaemia, dysrhythmia, or cardiac arrest. Methyl methacrylate induced myocardial depression and intrapulmonary deposition of platelet-fibrin aggregates have been implicated in the pathogenesis of bone cement implantation syndrome. Plasma levels of monomer measured intra-operatively in humans have been too low to account for haemodynamic changes. Intramedullary hypertension during insertion of the cemented prosthesis leads to embolization and thromboembolic intramedullary contents may be forced into circulation.

In uncemented THR absence of polymerizing bone cement, lower intramedullary pressures and decreased embolism of intramedullary debris does not lead to the above syndrome. In our series, there was no mortality either intra-operatively or in immediate post-operative period. CSE was the predominant anaesthesia technique employed for the surgery. The primary aim was to see if there were any significant changes in vital parameters around insertion of prosthesis in TJR. Surprisingly we did not find much significant haemodynamic changes around insertion of prosthesis in cemented THR. Inj. hydrocortisone and anti-histaminic (2ml/45mg pheniramine maleate, not in ASA III and > 70 years age) was given prophylactically in all patients prior to insertion of cemented prosthesis. We found significant rise in MAP after insertion of prosthesis in TKR. Correlation in TER cannot be commented as only 1 TER was performed in the period.

**CONCLUSION**

Our study revealed that when CSE was the predominant anaesthesia technique employed for the surgery. Clinically significant haemodynamic changes thought to be associated with insertion of implants is independent of age, ASA grading, cemented/uncemented provided patients are well optimized pre and intra-operatively and CVP is maintained. We feel that CVP monitoring is essential to optimize them.

**CORRESPONDENCE TO**

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References

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