INTRODUCTION:
Hip resurfacing using metal-on-metal bearings is an old concept and is a significant development in hip arthroplasty. It preserves proximal femoral bone stock, optimizes stress transfer to the proximal femur, and offers inherent stability and optimal range of movement [1]. The results of hip resurfacing in the 1970s and 1980s were disappointing, due, in part to poor machining tolerances, and the procedure was largely abandoned by the mid-1980s. The ability to now improve the manufacturing tolerances a resurgence of metal-on-metal articulations for total hip arthroplasty has enabled the introduction of new hip resurfacings. Early results are encouraging, and complications commonly seen in the 1970s and 1980s, such as early implant loosening are rare [2]. Because of the rapid increase in the number of procedures being performed, previously recognized complications have begun to recur. The current revival complications may be related to an increase in early failures owing to the challenging technique of the procedure. The Australian National Joint Registry (2004) states, in the years 2002-December 31st 2003, 3703 hip resurfacing procedures were performed. The revision rate was 1.9%, 67% of these were due to femoral neck fracture [3]. A better understanding of implant insertion procedure may help in understanding the early femoral neck fractures that have occurred. This study has investigated the impact loads associated with hip resurfacing surgery at the mallet, implant impactor and implant.

METHODS:
Ethics approval (04/025) was given for 4 groups of 6 patients to undergo hip resurfacing surgery prior to total hip surgery. Six patients have been enrolled to date and are in the group allocated the Birmingham Hip Resurfacing component (BHR, Smith & Nephew, Memphis, TN). Each patient underwent standard hip resurfacing surgery for the BHR and impaction loads were measured during placement of the femoral component using an instrumented hammer (Figure 1). Incorporating a 100kN piezoelectric load cell (224C ICP, PCB Piezotronics, Depew, NY). Force and time signals were collected using a dedicated A/D data acquisition board (PCMCIA 6024E, National Instruments, Austin, TX) at a sampling rate of 200kHz. Maximum force and energy was determined from the each hammer strike during implant seating. Theoretical curves were also developed using the finite difference method (Figure 2) to investigate the influence of mass and damping effects of the implant impacter and implant.

RESULTS:
Figure 3 presents demonstrates the maximum impaction force versus hammer strike during implant seating for single patient. An increasing impaction load was observed on each subsequent strike for all patients which may indicative of cement polymerization and implant seating. Maximum force during final seating was unexpectedly high (~25kN)

Figure 4 illustrates the theoretical curve and fitting to the clinical data for the same patient and shows a good approximation. These results suggest that the forces at the implant progressively increase (Figure 3) due to several effects. These include an increase in surface area applying a skin friction between the implant and bone; the cement interdigitisation and the cement’s polymerization process. This study has shown that the inferred impact loads applied to the underlying bone may predispose the bone to fracture and therefore affect the long term integrity of the joint replacement.

DISCUSSION:
While the measured hammer impaction loads were high; the mass and damping effects of the impacter significantly reduced the loads experienced by the resurfacing component. This was shown through the theoretical and in-vitro impact analysis (Table 1) which is an attempt to infer the load applied by the implant to the bone (FS in figure 2) through the analysis of the hammer strike on the impacter.

<table>
<thead>
<tr>
<th>Impact Number</th>
<th>Peak Hammer Force N</th>
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<tr>
<td>3</td>
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<td>5500</td>
</tr>
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<td>9</td>
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<td>8500</td>
</tr>
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<td>12</td>
<td>21090</td>
<td>9500</td>
</tr>
</tbody>
</table>

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REFERENCES:

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