Improved Hip Prostheses

Warwick Ventures has available for licence a patent application covering a truly ground breaking innovation in the design of hip prostheses which enables the reduction of “edge-loading” stresses responsible for the degradation of the devices over time.

BACKGROUND

Total hip replacement surgery is not generally available to everyone under the age of 50 years. This is because implants have a limited lifetime which means that surgeons generally only elect to operate on those unlikely to require a replacement device (i.e. the elderly).

Failure in implants is usually caused by “edge loading” stresses which occur as a consequence of partial dislocation of the ball within the acetabular cup of the socket as the patient moves and subsequent mis-alignment of the ball when re-entering the socket.

Such stresses have been proven to significantly increase the wear rate of the socket which consequently shortens the lifetime of a total hip joint prostheses and leads to production of often toxic nanoparticles which can accumulate within the tissue around the hip or in some case be dispersed throughout the body. This process happens in all types of hip prosthesis currently being used regardless of the material in use.

Our novel technology offers the prospect of implant designs with significantly reduced edge loading, addressing the issues of both reduced longevity and the production of nanoparticles. Because the lifetime of the implant is increased, our technology also facilitates elective surgery among a younger patient demographic, thereby generating a significant new market opportunity.

INVENTION

At the centre of our invention is the addition of a secondary ring to the acetabular cup which is then affixed to the main acetabular body at the end of the implant procedure. This secures the ball into the socket to stop any partial dislocation occurring upon movement, and minimises any edge loading stresses which arise from mis-aligned re-entry of the ball into the socket.

The new technology comprises a cup (Fig.1d) which is similar to conventional cups found in existing devices and a ring which is attached to the main body of the socket at the end of the hip replacement procedure.

The end face of the cup and the corresponding face of the ring are provided with complimentary features to enable alignment of the ring to the main body of the socket. This alignment feature is preferably in the form of a rib around the circumference of the ring and a complimentary groove extending around the inside edge of the socket (Fig.1d & Fig.1e). Once aligned, the rib will enter the groove and be fixed via the addition of a bio-compatible adhesive.

SMALL CHANGES CAN MAKE A BIG DIFFERENCE

The occurrence of micro-separation events between the ball and socket is the cause of edge loading stresses. Through the inclusion of our ring to the acetabular cup we limit the possible radial clearance of the ball from the socket to 40μm in all directions – meaning that the ball cannot get enough distance for edge loading to occur. Additionally, whenever the hip is flexed by more than 90°, the pressure from the superior part of the ball spreads to the ring rather than the socket edge, further reducing edge loading stresses.
Mathematical modelling of edge loading stresses within ball and socket joints have been performed on “traditional” designs (which do not contain our additional ring) and on our prototypes with a ring added.

**Figure 2: Edge loading stresses in “traditional” ball & socket joints**

![Image of edge loading stresses in traditional joints](image)

**Figure 3: Edge loading stresses in ball & socket joint with secondary acetabular ring**

![Image of edge loading stresses with acetabular ring](image)

2.8 KN to 20 KN force were applied to both prosthesis which are made with same dimensions and material. Von Mises Stresses were studied using the Finite Element Method. Both prosthesis have 250 micrometres displacement for being in edge loading condition.

As seen when comparing Figures 2 and 3 there is considerable reduction in edge loading stresses when the secondary acetabular ring is incorporated into the design. Details of these stresses are given in the table below:

<table>
<thead>
<tr>
<th>Applied Load (Von Mises Stress)</th>
<th>2.8 KN</th>
<th>5 KN</th>
<th>10 KN</th>
<th>20 KN</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Traditional” Ball</td>
<td>4.8 GPa</td>
<td>4.8 GPa</td>
<td>4.8 GPa</td>
<td>4.8 GPa</td>
</tr>
<tr>
<td>“Traditional” Socket</td>
<td>1.56 GPa</td>
<td>1.53 GPa</td>
<td>1.47 GPa</td>
<td>1.38 GPa</td>
</tr>
<tr>
<td>“With ring” Ball</td>
<td>135 MPa</td>
<td>240 MPa</td>
<td>470 MPa</td>
<td>910 MPa</td>
</tr>
<tr>
<td>“With ring” Socket</td>
<td>884 MPa</td>
<td>1.26 GPa</td>
<td>1.96 GPa</td>
<td>2.99 GPa</td>
</tr>
</tbody>
</table>

Stresses are reduced by up to three orders of magnitude in the presence of the acetabular ring

- Under 2.8 KN Force: \( \frac{4.8 \text{ GPa}}{1.56 \text{ GPa}} \times \frac{135 \text{ MPa}}{884 \text{ MPa}} \Rightarrow x = 20 \Rightarrow 95\% \text{ reduction of stress} 
- Under 5 KN Force: \( \frac{4.8 \text{ GPa}}{1.53 \text{ GPa}} \times \frac{240 \text{ MPa}}{1.26 \text{ GPa}} \Rightarrow x = 16.5 \Rightarrow 94\% \text{ reduction of stress} 
- Under 10 KN Force: \( \frac{4.8 \text{ GPa}}{1.47 \text{ GPa}} \times \frac{470 \text{ MPa}}{1.96 \text{ GPa}} \Rightarrow x = 13.6 \Rightarrow 93\% \text{ reduction of stress} 
- Under 20 KN Force: \( \frac{4.8 \text{ GPa}}{1.38 \text{ GPa}} \times \frac{910 \text{ MPa}}{2.99 \text{ GPa}} \Rightarrow x = 11.5 \Rightarrow 92\% \text{ reduction of stress} 

**BENEFITS**

Benefits of the technology include:

- A unique design which could facilitate the manufacture of hip prostheses with greater longevity
- Opens up new markets for hip prostheses – making earlier transplants a possibility.
- A simple easily manufactured design

**PATENT & PUBLICATION**

This technology is the subject of a patent application:

**International Patent Application No. PCT/GB2015/052933**

Title: “An Acetabular Cup for a Hip Replacement Joint”

The patent application and associated know-how is available for licence through Warwick Ventures Ltd.

**CONTACT**

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