Intracapsular components do not change hip proprioception
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We compared joint proprioception in 12 hips in 12 patients with hemiarthroplasty after fracture of the hip, in 12 hips in 11 patients with total hip arthroplasty because of osteoarthritis and in a control group of 12 age-matched patients with no clinical complaints. There was no significant difference (p = 0.05) in joint proprioception in any of the groups. There was no decrease in joint proprioception in the group with total hip arthroplasty compared with the hemiarthroplasty group or with the control group.

Other factors such as stretch receptors in the adjacent tendons and muscles may have a greater influence on proprioception in the hip than the intracapsular components.

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Most studies on joint proprioception have been performed on anterior-cruciate-deficient knees. Recently, there has been an increasing number of reports on proprioception in knees after arthroplasty, but very few on the hip. Errors in proprioceptive perception and in the visual and vestibular systems can induce faulty or delayed corrective responses resulting in disturbances of balance and falls.

Duncan et al identified proprioceptive perception as a factor influencing falls. It is important therefore to recognise to what extent replacement of intracapsular components, such as the femoral head and acetabulum, can affect proprioception in the hip. We compared proprioception in patients with hemiarthroplasty with those with a total hip replacement and with an age-matched control group.

Patients and Methods

We studied 23 patients who did not have any clinical complications after surgery and could walk independently at the time of evaluation. Twelve (12 hips) had had a hemiarthroplasty after a hip fracture and 11 (12 hips) a total hip arthroplasty (THA) because of osteoarthritis. Surgical capsulotomy had been performed in each. There were nine women and three men in the hemiarthroplasty group and ten women and one man in the THA group. Their mean age was 76 years (67 to 88). A control group consisted of 12 age-matched patients (24 hips), nine women and three men (Table I).

We performed the tests at a mean of 31 months (12 to 106) after surgery using an instrumented spatial linkage (ISL) electrogoniometer with 6° of freedom and an angular accuracy of 0.5° (Fig. 1) to measure hip flexion and abduction. The ISL has seven metal linkages interconnected by six electrical hinges or potentiometers which freely change their relative positions and orientations as the hip moves. By knowing the geometry of the links, the electrical parameters which characterise the potentiometer and the voltages generated by the potentiometers as the hip moves, the position of one end of the ISL can be computed relative to the other.

We secured the ISL to the side of the subject’s hip. Its ends were fixed to thin aluminium plates which were in turn attached as a guide parallel to the trunk and thigh by elastic cuffs, 30 cm in width. The position of each hip was

Table I. Details of the three groups

<table>
<thead>
<tr>
<th>Group*</th>
<th>Hips</th>
<th>Patients</th>
<th>Mean (±SD) age (yrs)</th>
<th>Mean follow-up (range) (mths)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>12</td>
<td>11</td>
<td>69 ± 4</td>
<td>25 (17 to 44)</td>
</tr>
<tr>
<td>Hem</td>
<td>12</td>
<td>12</td>
<td>75 ± 5</td>
<td>32 (12 to 106)</td>
</tr>
<tr>
<td>C</td>
<td>24</td>
<td>12</td>
<td>75 ± 3</td>
<td></td>
</tr>
</tbody>
</table>

* total, total hip arthroplasty; hem, hemiarthroplasty; C, control
estimated by palpating each greater trochanter. To confirm the accuracy of the device, the index angles of each subject were checked before the first and after the last test by both ISL and radiological measurements. Although the ISL can measure three translations and three rotations we report only flexion and abduction. We used the active-active method (A-A) as described by Good et al., meaning that the subject actively set both the initial and repeat angles. The tests were performed on one leg at a time randomly, with the tested leg hanging freely and the patient standing upright on the other leg.

The 'error' for the A-A test was calculated as the mean difference between the patients' repeat tests, each test serving as the index angle for the next. The resulting error terms were based on the mean of six trials made at 30° of flexion and 30° of abduction, respectively (Fig. 2). Differences between the control subjects and those in the arthroplasty groups were evaluated by comparing the means of the absolute values of resulting 'errors' by non-parametric ANOVA (Kruskal-Wallis test).

Results
There was no statistically significant difference in any of the groups in flexion (control group, 5.4 ± 3.1°; hemiarthroplasty, 5.6 ± 3.5°; total arthroplasty, 4.4 ± 2.0°;...
prosthesis, and resurfacing of the patella, and with or without cement for fixation and found no significant difference in any of the groups or with an age-matched control group which had not had TKR. We concluded that knee replacement did not affect proprioception and that extracapsular components such as stretch receptors in the adjacent tendons and muscles rather than intracapsular receptors may influence proprioception in the knee.

Decline of or errors in proprioceptive perception of the environment, as well as in the visual and vestibular system can lead to falls by inducing faulty or delayed corrective responses. \(^16,17\) Most total hip and knee arthroplasties have been highly successful. To our knowledge, there have been no reports that patients are more prone to falling after arthroplasty of either the knee and hip. It could be hypothesised that in both the knee and hip there are substantial extracapsular components, such as stretch receptors in the adjacent tendons and muscles, which may have a greater influence on joint proprioception than intracapsular components, such as the acetabulum and femoral head, in the elderly. The latter did have an age-related decline in joint proprioception. Our findings may suggest why multiple joint replacements in patients with rheumatoid arthritis are successful with few complications or an increased risk of falling.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

References


<table>
<thead>
<tr>
<th>Group*</th>
<th>Flexion</th>
<th>Abduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>4.4 ± 2.0</td>
<td>2.0 ± 2.0</td>
</tr>
<tr>
<td>Hem</td>
<td>5.6 ± 3.5</td>
<td>4.0 ± 2.7</td>
</tr>
<tr>
<td>C</td>
<td>5.4 ± 3.1</td>
<td>3.6 ± 1.8</td>
</tr>
</tbody>
</table>

*p = 0.622* or in abduction (control group, 3.6 ± 1.8°; hemiarthroplasty, 4.0 ± 2.7°; total arthroplasty, 2.9 ± 2.0°; *p* = 0.348; Table II).

Discussion

There has been an increasing number of reports\(^7-13\) on proprioception in the knee after arthroplasty, but only very few\(^14,15\) on the hip. These studies, on the hip and the knee, measured passive positioning using visual analogue methods or by determining the threshold to joint movement. We realised that passive techniques were not reliable and had very large tolerance intervals, as has been shown by Gottlieb et al\(^19\) and Good et al.\(^5\) Gottlieb et al\(^19\) reported that the active method was more accurate, more repeatable, and represented physiological activities more precisely in the walking patient. We therefore used this technique to compare three different conditions of the intracapsular component to determine to what extent each affected joint proprioception. Previous studies\(^14,15\) have compared only affected and non-affected sides.

Our findings showed no difference in proprioception in hips with replacement of only the femoral head compared with those in which both the femoral head and the acetabulum had been replaced, and no significant difference between these and an age-matched control group without any clinical complaints. This does not mean that proprioception was completely normal in both groups. The slight lack of proprioceptive ability in the post-arthroplasty group matched that seen in the age-matched control group, and may indicate the loss of proprioception seen with advancing age in both groups. Skinner, Barrack and Cook\(^20\) and Kaplan et al\(^31\) also reported an age-related decrease in joint proprioception.

Some of the studies on knee arthroplasty have shown that retention or substitution of the posterior cruciate ligament (PCL),\(^13\) the use of a semiconstrained or hinged prosthesis,\(^8\) and resurfacing of the patella\(^13\) affect proprioception. Recent studies, however, have not supported these results. Cash et al\(^9\) reported that substitution or retention of the PCL made no clinical difference to proprioception as measured by threshold testing and Simmons et al\(^12\) did not show any difference in proprioception between patients with unicondylar and total knee arthroplasty, with or without retention of the PCL. Retaining the PCL does not appear to give improved proprioception. In a previous study\(^10\) we compared proprioception after semiconstrained total knee arthroplasty performed with or without retention of the PCL, with or without resurfacing of the patella, and with or without cement for fixation and found no significant difference in any of the groups or with an age-matched control group which had not had TKR. We concluded that knee replacement did not affect proprioception and that extracapsular components such as stretch receptors in the adjacent tendons and muscles rather than intracapsular receptors may influence proprioception in the knee.

Table II. The mean (±sd; degrees) error term and inaccuracy for each group

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>4.4 ± 2.0</td>
<td>2.0 ± 2.0</td>
</tr>
<tr>
<td>Hem</td>
<td>5.6 ± 3.5</td>
<td>4.0 ± 2.7</td>
</tr>
<tr>
<td>C</td>
<td>5.4 ± 3.1</td>
<td>3.6 ± 1.8</td>
</tr>
</tbody>
</table>

* total, total hip arthroplasty; hem, hemiarthroplasty; C, control group


