

Manuscript Title:

Activity levels following hip resurfacing arthroplasty: A tool to help manage patient expectations.

Short Title:

Trends in Activity Level Post Hip Resurfacing Arthroplasty: A Prospective Cohort Study

Authors:

Jack Martin¹, Mark Williams² and Karen Barker³

¹ BSc (Hons) Physiotherapy Student, Oxford Brookes University, Oxford, UK

² Department of Sport and Health Sciences, Oxford Brookes University, Oxford, UK

³ Physiotherapy Research Unit, Nuffield Orthopaedic Centre, Oxford University Hospitals NHS Trust, Oxford, UK

Corresponding Author:**Abstract:**Background:

When compared to total hip arthroplasty (THA), hip resurfacing arthroplasty (HRA) is usually undertaken in younger, more active patients with osteoarthritis compared with total hip arthroplasty. Previous research has noted that patients are able to return to pre-operative levels of activity, with some increasing their levels of activity post HRA, but patterns in post-operative recovery have been less well investigated.

Materials and Methodology:

A randomised controlled trial dataset was analysed to explore activity levels attained after HRA. Data was collected on 80 male patients. The primary outcome of focus was the University of California, Los Angeles (UCLA) Activity Index, with follow ups at 6 weeks, 16 weeks and 1 year.

Results:

Mean UCLA at baseline was 5.4 (SD;2.1) which after an initial fall to 4.7 [SD 1.6 p=0.008] at 6 weeks increased at both the 16 week and 1 year follow up (p<0.001) with a final mean activity index of 7.2 (SD;1.7). Mode UCLA at 1 year was 7 or 8, representing patients who are regularly taking part in activities such as cycling or golf.

Conclusion:

Following HRA, patients can achieve significant improvements in activity measured using the UCLA Activity index. Activity levels have been shown to initially decrease following HRA, with improvement throughout the first postoperative year. The results of this study provide clinicians with a simple tool to help patients visualise their postoperative recovery. This may have implications when managing patient expectations of post-operative activity level in both HRA and large head THA populations.

Key Words:

Hip Resurfacing Arthroplasty, Physiotherapy, Activity Levels, Functional Recovery.

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Introduction:

The number of primary hip replacements recorded in the UK since the National Joint Registry's inception in April 2003 has now reached almost 900,000. Of all hip replacement subgroups, hip resurfacing arthroplasty (HRA) has the youngest population at a median age of 55 ^[1]. Due to this younger population, many patients wish to return to their previous level of physical activity, with some patients that had not previously taken part in sporting activities prior to surgery, being able to take up some level of sport after HRA ^[2-4]. The HRA procedure itself presents several advantages over conventional total hip arthroplasty (THA) including bone stock preservation, reduced dislocation rates and return to impact activity ^[5]. In addition it is suggested that gait characteristics in patients following HRA are more normal than those who have undergone THA ^[6], and overall the procedure has provided excellent success rates in these populations with survival rates reported at over 95% at 10 years ^[7-9]

The outcomes of HRA have been well investigated, with the procedure noted as an attractive treatment option for the younger active population ^[10,11]. Nevertheless, has not been without controversy due to the concern over adverse reactions to metal debris due to the wear of metal components ^[12,13]. Whilst recent research has shown problems with metal sensitivity reaction in patients of small stature and women leading to MHRA guidance, the use of resurfacing arthroplasty is still a recommended treatment for younger male patients. Although metal-on-metal (MOM) resurfacing implants account for only 4.4% of hip replacements since April 2003, current HRA research may be applicable to large head THA and short femoral metaphyseal stem arthroplasties, due to the advantages and functional outcomes that these tissue preserving techniques share ^[11,14].

Activity level and return to sporting activity have been reported on by experts in THA ^[15,16]. This has provided a consensus on return to specific activities; however no such consensus exists within the HRA literature. Return to sport following HRA has been investigated suggesting that activities can be maintained, particularly in the case of lower impact sports such as golf and swimming, but patients were less likely to take part in higher impact sports such as football and badminton ^[2]. Other authors have come to a similar conclusion, noting that patients are able to return to activities at pre-operative intensity, maintaining activity levels with few complications ^[17]. There have also been attempts to identify correlations and predictors of function, noting associations between self-reported functional questionnaires and observed outcome measures ^[23] as well as predictors such as age, male sex and pre-operative activity level ^[18], but trends in activity level post HRA have been less well investigated.

With this in mind, further research in this area is of importance as these results may have implications for realistic functional goal setting, pre-operative assessment, and altered emphasis on activity levels within both HRA and large head THA populations. This study aims to report on trends in activity levels and functional outcomes of patients through the first post-operative year following HRA.

Materials and Methods:

Data analysis was performed on a pre-existing dataset. This data was originally collected for a randomised controlled trial with follow ups at six, 16 and 52 weeks, attempting 'to identify if a tailored rehabilitation programme is more effective than standard practice at improving function in patients undergoing metal-on-metal hip resurfacing arthroplasty' [19]. Data were collected on a total of 80 male patients who underwent HRA performed by five different consultant-grade orthopaedic surgeons, using their preferred approach and prostheses.. Exclusion criteria included patients due for bilateral arthroplasty or minimally invasive surgery, patients in whom further lower limb joint surgery was planned within 12 months and patients unable to provide informed consent.

. Primary outcomes were University of California, Los Angeles (UCLA) Activity Index, a simple self-reported 10 point scale measuring activity levels, Oxford Hip Score (OHS), a short 12 item questionnaire used to assess hip function and pain and Hip disability and Osteoarthritis Outcome Score (HOOS), a 10 minute questionnaire, split into five subsections, designed to evaluate symptoms and functional impairments of the hip . These measures were collected at baseline, six weeks, 16 weeks, and 52 weeks following HRA. Secondary outcomes included hip range of motion (ROM) and strength. For the purposes of this analysis, both the control and intervention group data were combined, producing a prospective cohort study design of 80 male patients..

UCLA activity index was the primary outcome of focus during this analysis, which has been shown to be a reliable and valid tool for assessment of activity levels in patients undergoing total joint arthroplasty, specifically THA, with superior metric properties when compared to other instruments such as the Tegner Activity Scale.[20]

Statistical analyses were performed using IBM SPSS version 23 ¹. There were 30 cases (9.4%) of missing data from the UCLA Activity Index throughout the four follow ups (320 data sets) which were excluded from the analysis. The Wilcoxon Signed Rank test was used to analyse related non-parametric data and Mann-Whitney U for unrelated non-parametric data. The Chi-Squared test for association and Pearson correlation were used to assess for the association between characteristics. Variables were categorised for association analysis. UCLA Activity Indexes were categorised into low activity ($UCLA \leq 6$) and high activity ($UCLA \geq 7$), OHS was categorised into, excellent (42–48), good (34–41), fair (27–33), and poor (0–26) and Body Mass Index (BMI) was categorised into underweight ($BMI \leq 18.4$), healthy ($BMI 18.5–24.9$), overweight ($BMI 25.0–29.9$) and obese ($BMI \geq 30.0$).

Significance was defined at $p < 0.05$.

Results:

Demographics

Eighty male patients were included in the analyses with a mean age of 54 (SD;8.5) , comprising 38 (47.5%) right and 42 (52.5%) left operated hips. Thirty five patients (43.8%) reported that a single hip was affected (Charnley classification class A), 36 (45%) described both hips as affected (class B) and 8 patients (10.0%) stated that multiple joints were affected (class C).

Complications

In the first year, 2 patients (2.5%) had their HRA revised to a THA following femoral neck fractures, and 2 patients (2.5%) had further surgery (one for heterotrophic ossification and one had fluid aspirated from the groin). Two patients (2.5%) had unconfirmed adverse reactions to metal debris. There were no reported cases of deep infection, aseptic loosening or dislocation (Table 1).Function

Self-reported functional outcomes (Table 2) showed a significant improvement in OHS and HOOS ($p < 0.001$) comparing scores at baseline and 1 year. The most statistically significant change in HOOS questions were the symptoms and pain subscale scores ($p < 0.001$). The number of patients that classed their walking as unlimited rose from 43 (53.8%) to 66 (82.5%) ($p < 0.001$), and those that reported a normal gait pattern when climbing stairs increased from 34 (42.5%) to 66 (82.5%) ($p < 0.001$).

At the start of the study, patients were asked to identify a specific functional goal they hoped to achieve following surgery, such as skiing, kneeling, playing with grandchildren and travelling on holiday without pain. After 1 year, 51 patients (63.7%) had fully, and seven patients (8.8%) had partially achieved their goal.

Activity Level

Trends in UCLA activity scores (Figs. 1 and 2 and Table 3) show the mean UCLA at baseline was 5.4 (SD; 2.1) which, after an initial fall to 4.7 (SD; 1.6, $p=0.008$) at 6 weeks, increased at both the 16 week and 1 year follow ups ($p < 0.001$), with a final mean activity index of 7.2 (SD; 1.7). Median UCLA scores did not improve between 16 weeks and 1 year follow up. Patients in this study population were most likely to report a UCLA activity index of 7 or 8 at 1 year.

3.5. Association analysis

Impairment characteristics were analysed for correlation with functional outcomes. There was a statistically significant correlation between activity levels at baseline and activity levels at 1 year ($p=0.014$). There were no cross sectional or longitudinal correlations between activity levels and hip ROM or strength. Likewise, there was not a significant association between activity levels and self-reported functional questionnaires (HOOS and OHS) at baseline or 1 year. HOOS and OHS scores, however, show significant correlation with each other throughout the follow up period ($p < 0.001$).

Discussion:

With the average age of patients being treated with THA decreasing, many of this younger and more active population wish to return to sporting activity following the procedure.^{21,22} There are many theorised advantages that HRA offers over traditional THA including reduced episodes of dislocation and near normal ROM. These are responsible for the superior reputation of HRA with patients who wish to return to sports and high levels of activity.^{10,21} In previous studies that have investigated activity level in patients following HRA, it has been reported that patients are able to return to baseline activity levels in the mid to long term.^{2,17,22} However, there is little consensus on the recommendations or prohibitions on return to sporting activity following HRA, despite this being a younger and more active population. This analysis demonstrated the trends in activity level following HRA and showed similar results to the current literature, with 96% of patients engaging in high levels of activity pre-operatively, being able to return to this level by 1 year postoperatively. Additionally, some patients in this study significantly increased their levels of physical activity, with 54% of the population who were categorised as having low activity levels at baseline; achieving high levels of activity by their 1 year follow up.

Trends in activity level over the first postoperative year following HRA are described in this analysis. These trends are characterised initially by a statistically significant fall in activity, recorded at 6 weeks, followed by improvement to the 16 week and 1 year follow up (Fig. 1). Patients in this population were most likely to achieve UCLA scores of 7 or 8 (active and very active) at 1 year, which represents patients who are regularly taking part in activities such as cycling, swimming and golf. This finding concurs with other current literature on return to specific sporting activities following HRA, which shows that although the number of sporting activities patients undertake decreases after surgery, more patients are able to take up lower impact sports, such as cycling.^[3,20] The analysis also shows an association between activity levels at baseline and 1 year, with patients engaging in higher levels of activity pre-operatively, returning to higher levels of activity post-operatively. This poses the question as to whether rehabilitation should take place prior to surgery (prehabilitation) and whether this would be effective in improving post-operative activity levels. Current evidence is limited to two systematic reviews investigating the effect of prehabilitation on patients undergoing joint replacements. It suggests that prehabilitation may reduce the length of stay and slightly improve early postoperative function and pain,^{23,24} though there is currently no evidence within HRA populations.

Whilst a significant fall in activity level was found at the 6 week review, it is difficult to discern whether this fell any further before or after this follow up due to the design of the original trial. Radiographic and surgical outcomes are considered over the long term within the current literature,^[25] however, functional and physiotherapy specific research studies rarely have follow up beyond 1 year. Although a 1 year follow up is thought to be representative of mid to long term results, owing to the notion that most of the recovery occurs within the first postoperative year,¹⁸ the results of this study suggest that there may have been further improvement in activity levels beyond this point, as mean UCLA had not reached a plateau. A study designed to specifically investigate activity levels following HRA may benefit from recording activity levels more frequently and for longer postoperatively. This could provide a clearer view of the fall in activity identified in this study, when activity levels start to recover and where the plateau in activity may lie.

Although HRA is popular among younger and more active patients, it is also important to note that not all patients wish to return to high levels of activity following HRA. This is highlighted by Banjeree et al,[3] who showed that many patients voluntarily gave up some sporting activities post-operatively. With no consensus on return to sporting activity following HRA, the advice from clinician's varies. Return to low impact activity such as cycling is often advocated, as the general effects of exercise are well stated, however, guidance regarding higher impact activities such as jogging and soccer are inconsistent. Banjeree et al [3] stress this as an important consideration for active patients considering HRA, as a third of patients in their series reported missing the activities that they gave up.

Our study showed complication rates comparative with the current literature. After 1 year, 2 patients underwent revision surgery following femoral neck fractures (3 and 4 weeks postoperatively), 2 patients had further surgery for heterotrophic ossification and to drain fluid from the hip, and there were 2 unconfirmed cases of adverse reactions to metal debris. At the time of writing these unconfirmed cases are still being monitored, although no other interventions have been undertaken. With a mode UCLA Activity Index of 7 at 1 year (range 6–9) these 6 patients reported activity levels that were in line with the remaining population who did not experience complications. Additionally, the trends in their self-reported activity level were similar, with these 6 patients experiencing a fall in activity at 6 weeks, followed by improvement to the 1 year follow up. Although some patients are able to return to activities at pre-operative intensity, maintaining activity levels with few complications,¹⁷ it is still unclear whether these patients are more at risk of complications compared with those who are less active. Concerns over aseptic loosening and accelerated wear of the components due to increased activity level are shared within THA literature; however the impact of activity levels on these complication rates has not been investigated in HRA.[4].

Goal setting often forms an integral part of rehabilitation following orthopaedic surgery. These goals often focus on the level of activity or restriction, with examples in this study's population including playing with grandchildren and skiing. The clinicians understanding of rehabilitation potential post HRA is an important factor when considering realistic goals. This is of particular importance as only 64% of patients in this population fully achieved their pre-operative goal after 1 year. Providing clinicians with a simple guide on the trends in activity level following HRA which may be shared with patients, such as in Fig. 1, may prove an important tool in managing patients' expectations of postoperative activity levels, and in aiding clinicians in this realistic goal setting process.

HRA is an attractive procedure for younger more active patients wishing to maintain their pre-operative levels of activity. Pre-operative education on expectations of function post-operatively is therefore paramount. Although individual patients may report lower or higher activity levels than demonstrated in our study's population, we theorise that most patients will follow the general trend depicted in Fig. 1. We have also shown this to be applicable to patients with post-operative complications such as femoral neck fracture. This simple graph can be quickly and easily illustrated in an outpatient setting to allow patients to visualise their post-operative recovery and when they may reach a plateau in their levels of activity.

Limitations

For the purposes of this design, both the intervention and control groups from a randomised control trial were combined. There was a significant difference between groups in the original study, including in the self-reported functional outcomes utilised in this study, most notably in OHS, in which the intervention group showed nearly a 50% larger improvement than the control. As the general population do not undergo a tailored accelerated rehabilitation protocol, the results may be less transferrable. However, as many of

the results discussed relate to UCLA Activity Index, which showed no significant difference between groups throughout the 1 year follow up period, the combination of both groups may be justified. With the relatively small sample size, the statistical analyses regarding associations between variables may not have a significant power, and certainly correlations and predictors of activity levels that have been quoted in previous studies, such as BMI, were not evident in this population.

Conclusions

Following HRA, patients can achieve significant improvements in self-reported activity and functional outcomes, including scores in pain and symptoms, comparable with that of the current literature. Activity levels have been shown to initially decrease following HRA, improving throughout the first postoperative year, with patients most likely to rate their levels of activity as 'active' and 'very active' at 1 year. The results of this study provide clinicians with a simple tool to help patients visualise their post-operative recovery. This may have implications by helping with realistic goal setting and managing patient expectations of post-operative activity level in both HRA and large head THA populations,

Financial support

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Conflict of interest

No conflicts of interest are declared.

Informed consent

Ethical approval was gained from the Local REC: 06/Q1605/110.

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Figure Legends

Figure 1:

Trend in UCLA Activity Index Scores through the first postoperative year. Mean UCLA Activity Index is shown at baseline, 6, 16 and 52 weeks. This line graph demonstrates a fall in activity recorded at 6 weeks, with improvement above baseline to the 16 and 52 week follow ups.

Figure 2 (a-d):

Frequency of UCLA Activity Index Scores through the first postoperative year. Frequency of each individual activity score (1-10) is shown at baseline (a) 6 weeks (b) 16 weeks (c) and 52 weeks (d). These bar charts demonstrate an initial skew to lower UCLA Activity Index Scores at baseline and 6 weeks (a,b) with a shift to higher scores at 16 and 52 weeks (c,d).

Figure 3:

Trend in UCLA Activity Index Scores split by control and intervention groups from the original trial. Mean UCLA Activity Index is shown at baseline, 6, 16 and 52 weeks for both control (orange) and intervention (blue) groups. This multiple line graph demonstrates similar trends in both groups, with higher scores at the 6 and 16 week follow ups with regard to the intervention group.

Table 1. Self-Reported Functional Questionnaires

UCLA, median (IQR)

| | |
|----------|-----------|
| Baseline | 5.0 (4.0) |
| 52 weeks | 7.0 (2.0) |

Oxford Hip Score, mean (SD)

| | |
|----------|------------|
| Baseline | 25.9 (8.3) |
| 52 weeks | 44.3 (7.0) |

HOOS, mean (SD)

Total

| | |
|----------|-------------|
| Baseline | 46.3 (14.7) |
| 52 weeks | 87.6 (13.9) |

Symptoms

| | |
|----------|-------------|
| Baseline | 48.9 (19.8) |
| 52 weeks | 88.7 (15.4) |

Stiffness

| | |
|----------|-------------|
| Baseline | 45.2 (17.4) |
| 52 weeks | 84.4 (19.8) |

Pain

| | |
|----------|-------------|
| Baseline | 49.5 (14.8) |
| 52 weeks | 92.8 (14.7) |

Function of Daily Living

| | |
|----------|-------------|
| Baseline | 57.6 (17.4) |
| 52 weeks | 94.1 (10.8) |

Function of Sport

| | |
|----------|-------------|
| Baseline | 32.7 (20.0) |
| 52 weeks | 82.4 (21.7) |

Quality of Life

| | |
|----------|-------------|
| Baseline | 38.5 (15.9) |
| 52 weeks | 80.8 (20.3) |

UCLA, *University of California Los Angeles Activity Score*; HOOS, *Hip disability and Osteoarthritis Outcome Score*; OHS, *Oxford Hip Score*; IQR, *Interquartile Range*; SD, *Standard Deviation*.

| Table 2. UCLA Activity Level Trends | | | | |
|--|----------|---------|----------|----------|
| | Baseline | 6 weeks | 16 weeks | 52 weeks |
| Mean | 5.4 | 4.7 | 6.2 | 7.2 |
| Median | 5.0 | 4.0 | 7.0 | 7.0 |
| Mode | 3 | 4 | 7 | 7,8 |
| Std. Deviation | 2.1 | 1.6 | 1.8 | 1.7 |
| Variance | 4.2 | 2.5 | 3.2 | 3.0 |
| Range | 8 | 8 | 8 | 9 |

| Table 3. Hip Muscle Strength | | | | | | | |
|-------------------------------------|----------|---------------|--------------|-----------------|----------------|-----------------|----------------|
| | | Right Flexion | Left Flexion | Right Extension | Left Extension | Right Abduction | Left Abduction |
| Right Hip Operated | Baseline | 15.5 (7.4) | 20.4 (6.1) | 13.0 (6.1) | 13.7 (5.6) | 12.7 (5.6) | 15.5 (4.4) |
| | 52 weeks | 31.0 (13.2) | 29.2 (12.3) | 20.3 (9.2) | 19.3 (9.4) | 22.5 (9.7) | 23.7 (9.9) |
| Left Hip Operated | Baseline | 20.4 (5.6) | 15.8 (5.4) | 13.9 (4.0) | 13.1 (3.9) | 15.8 (4.1) | 13.3 (4.5) |
| | 52 weeks | 31.2 (11.9) | 28.5 (10.9) | 19.9 (8.3) | 20.3 (9.0) | 23.7 (10.4) | 23.6 (10.9) |
| Muscle strength (NM), mean (SD) | | | | | | | |

| Table 4. Hip Range of Motion | | | | | | | |
|--------------------------------------|----------|---------------|--------------|-----------------|----------------|-----------------|----------------|
| | | Right Flexion | Left Flexion | Right Extension | Left Extension | Right Abduction | Left Abduction |
| Right Hip Operated | Baseline | 83.6 (18.5) | 98.6 (14.2) | 18.5 (14.7) | 25.0 (13.5) | 20.0 (8.0) | 29.5 (8.6) |
| | 52 weeks | 98.1 (16.1) | 101.3 (17.8) | 19.9 (7.9) | 19.9 (8.94) | 29.1 (10.2) | 28.6 (11.1) |
| Left Hip Operated | Baseline | 97.1 (13.9) | 83.8 (20.6) | 27.2 (15.4) | 18.3 (15.0) | 29.7 (8.1) | 19.7 (8.8) |
| | 52 weeks | 97.8 (15.0) | 99.2 (13.4) | 20.4 (9.2) | 20.4 (9.1) | 29.3 (7.0) | 28.4 (8.5) |
| Range of motion (degrees), mean (SD) | | | | | | | |