# SIT-TO-STAND GROUND REACTION FORCE CHANGES AFTER HIP RESURFACING OR TOTAL HIP REPLACEMENT: A PILOT STUDY

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## SUMMARY
Two groups of osteoarthritis patients had their ground reaction forces measured during a sit-to-stand task at three months post-operation. One group had a 32mm femoral head fitted during a total hip replacement procedure and the other group had a hip resurfacing procedure. Three validated orthopaedic score questionnaires and an activity questionnaire were completed prior to surgery and at three months post-operation. This pilot study showed that there were no significant differences in the ground reaction forces in the operated and non-operated limb between the groups although both groups exhibited significantly higher ground reaction forces on the non-operated limb compared to the operated one. None of the orthopaedic scores showed any significant differences between the groups, despite the resurfacing group reporting higher levels of sporting activity at three months post-operation.

## INTRODUCTION
Larger femoral heads used in hip reconstruction surgery are reported to provide better functional outcomes for osteoarthritis (OA) patients than smaller heads as a result of their improved biomechanics [1]. Hip resurfacing (HR) is a bone preserving procedure in which a cap, similar in size to the original anatomy, is fitted over the original femoral head. It is believed that HR should give improved biomechanics compared to small head total hip replacement (THR) due to the original anatomy being preserved more closely than that found with THR [2]. This study aimed to determine if there were differences in the biomechanics of two groups of OA patients fitted with either a large or a small femoral. The larger femoral head group were represented by a group of HR patients while the smaller femoral head groups were represented by a group of THR patients.

## METHODS
Six patients who had undergone hip reconstruction surgery for osteoarthritis were tested three months after surgery in the Gait Lab of Northumbria University in Newcastle. Three of these patients had a THR using a small femoral head (32mm diameter) and the other three had the HR procedure. All procedures were performed using the modified Hardinge approach. In all cases the patient had unilateral THR or HR and had no other lower limb surgery. Table 1 shows the gender and age breakdown of the two groups of patients.

**Table 1**: Sex and age breakdown of participants.

| Group | Sex (m/f) | Age (mean, SD, range) |
|---|---|---|
| THR | (0/3) | 63.33 (6.79, 59-66) |
| HR | (3/0) | 52 (16.10, 35-67) |

During the testing session, participants performed a sit-to-stand task while each foot was positioned on a force plate (OMR-6-7, AMTI, Watertown, Massachusetts). With both feet on the floor and with the arms placed across the body hands placed on the opposite shoulder with the hands on the opposite shoulder, the participants were asked to rise from a fixed height stool to a fully standing position.
Normalised ground reaction forces (GRFs) from three trials per participant were analysed. In all cases the GRFs during the standing motion for the operated limb were less than or equal to that for the non-operated limb. From each trial, the peak GRF for the non-operated limb was determined and noted along with the value for the operated limb at the same point in the movement. For each trial, the mean of the extracted GRFs for the operated and non-operated limb were determined. Differences in GRFs were calculated between the operated and non-operated limb for each group.
Comparisons were made between the mean values of GRF for the operated and non-operated limb for each group, for the operated limb and the non-operated limb between groups and for the differences between the operated and non-operated limb between the groups.
Scores from the Harris Hip Score (HHS), Oxford Hip Score (OHS) and WOMAC orthopaedic questionnaires determined both immediately pre-operatively and at the three month post-operative testing session. Participants were also asked to complete an activity level questionnaire.
Tests for normality were performed on the data using the Shapiro Wilk test and the data was found to be normal. Thus, Independent samples t tests were performed on the GRF data and Wilcoxon signed rank tests on the orthopaedic score data to determine significance ($p=0.05$).

## RESULTS AND DISCUSSION
No significant difference was found when comparing the mean ages of the two groups. For both groups, significantly less load was applied through the operated limb compared to the non-operated limb during rising from the stool ($p=0.010$, THR group; $p=0.003$, HR group) (Table 1). No significant differences were found when comparing the operated limb or the non-operated limb between groups ($p=0.268$, operated

limb; p=0.635, non-operated limb) (Table 2). Neither was there any significant difference in GRF between the groups (p=0.771) (Table 3).

**Table 2**: Ground reaction forces (GRF) in % body weight.

| | THR group | HR group | p value |
|---|---|---|---|
| GRF %BW (operated) (SD) | 40.20 (6.31) | 45.07 (1.79) | 0.268 |
| GRF %BW (non- operated) (SD) | 64.30 (6.35) | 66.79 (5.45) | 0.635 |
| p value | 0.010 | 0.003 | |

**Table 3**: Differences in ground reaction forces between operated and non operated limb.

| | THR group | HR group | p value |
|---|---|---|---|
| Difference %BW (SD) | 24.11 (11.22) | 21.72 (7.17) | 0.771 |

None of the orthopaedic scores showed any significant differences between the groups, either pre-operatively or at three months post-operatively. When looking at the individual scores, there was a tendency for those in the HR group to be slightly higher although the means of the HHS at three months post-operation were the same (Table 4).

**Table 4:** Orthopaedic scores at pre-op and 3 months post-op (mean, SD).

| | HHS | | OHS | | WOMAC | |
|---|---|---|---|---|---|---|
| | Pre | 3m | pre | 3m | pre | 3m |
| THR | 37.7 (11.78) | 70.7 (22.68) | 15.0 (8.54) | 34.3 (12.42) | 33.0 (9.92) | 75.0 (20.10) |
| HR | 46.7 (8.96) | 70.7 (16.17) | 19.0 (7.21) | 41.0 (4.36) | 48.4 (17.25) | 84.7 (7.38) |
| P value | 0.285 | 1.000 | 0.276 | 0.285 | 0.285 | 0.109 |

When asked, prior to surgery, about how active they had been before OA had become a problem, all members of the HR group reported higher pre-operative levels of general (HR, 4-5; THR 2-3) and sporting activity (HR, 4-5; THR 1-3) than the THR group. When asked about their current level of activity, all patients reported that their general and sporting activity levels had reduced during the period of their illness (general: HR, 2-3; THR, 1-2; sport: HR, 1-2; THR, 1). Three months post-operatively, the reported levels of general activity were more equal (HR, 3-4; THR 3-4) although there was still a large difference in the sporting activity levels (HR, 3-4; THR 1).

This study has shown that three months after hip reconstruction surgery there are still disparities between the operated and non-operated limb, irrespective of the size of the femoral head used. Both of the groups demonstrated that around two thirds of the force used to rise from the stool was being generated by the non-operated limb. This is to be expected as the patient would not be fully recovered, since it is believed that the majority of the recovery would have occurred after six months [3].

No differences were found between the groups for any of the parameters investigated. No significant difference in limb loading was noted in another study which compared HR to THR during level walking after three months [4], although they did find that the operated and non-operated limbs applied a more equal GRF than observed in the current study. Given that the sit-to-stand task is a more demanding task, then a greater difference in the GRF can be expected.

One criticism of comparing different THR with HR is that the patient groups tend to be much different [2, 5]. In this study all HR patients were male while all of the THR patients were female. Although there was an 11 year difference in the means of the two groups, this was determined not to be significant. These differences in patient demographics were unavoidable since patient age, gender and bone degeneration will determine the procedure undertaken to a large extent.

These differences did not appear to affect the results given that the younger group would be expected to perform better. Activity levels prior to OA onset and immediately post-operatively will also determine post-operative abilities.

It is known that long periods of limited activity, such as in OA, cause atrophy [6, 7] and part of the recovery process post-operatively is to increase the strengths of the muscles. There is an implication in the results from the activity questionnaire that those in the HR group were more active than those in the THR group and may have suffered from less muscle wastage. This would suggest that, given the perceived benefits of larger heads and the more active members, the HR group would perform significantly better than the THR group. This is would also be expected from the reported superior levels of sporting activity by the HR group at three months post-surgery.

## CONCLUSIONS

This study has shown that despite the apparent benefits of using large femoral heads, the reported higher activity levels of the HR group and their slightly younger age, there was no significant difference in the operated/non-operated limb GRF between a group of hip replacement patients with a small 32mm femoral head and a group of hip resurfaced patients at three months post-operation. There were significant differences within both groups when comparing the GRF values of the operated against the non-operated limb.

The study highlighted that the hip resurfacing patients were more active and were more sporting than the hip replacement patients. However, this was not supported by the results from the orthopaedic scores which showed no difference either before or after the surgery.

This study presents only preliminary findings of a small group of patients and it is hoped that as more patients are added to the collection a more powerful study will be able to report more definitive findings.

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