Husby VS, Helgerud J, Bjørgen S, and et al. Early maximal strength training is an efficient treatment for patients operated with total hip arthroplasty. Arch Phys Med Rehabil 2009;90: 1658-67.

and

Husby VS, Helgerud J, Bjørgen S, and et al. Early postoperative maximal strength training improves work efficiency 6–12 months after osteoarthritis induced total hip arthroplasty in patients younger than 60 years. AmJ Phys Med Rehabil 2010; 89:304–314.

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Design: Randomized clinical trial

Objective: To determine if adding a maximal strength training intervention to a conventional hip rehabilitation program in the early postoperative phase after undergoing total hip arthroplasty (THA) produces better short-term (5 weeks post-op) (Husby 2009) and long-term outcomes after 6 and 12 months (Husby 2010) in terms of muscle and abductor strength and work efficiency than a conventional hip rehabilitation program alone.

Population /sample size/setting:

- Twenty-four volunteers (9 men, 15 women) aged < 70 years of age with hip osteoarthritis (OA) scheduled for THA were recruited to participate in the study from the orthopedic department at a University hospital in Norway. Participants were randomly assigned to 1 of 2 groups, a group performing maximal strength training in addition to the conventional rehabilitation program (STG) (STG; n = 12, mean age = 58) or to a group that participated in a conventional rehabilitation program only (CRG). (CRG; n = 12, mean age = 56). Two patients in the CRG group withdrew from the study prior to the 12 month test.
- Inclusion criteria included age <70 years, a diagnosis of primary osteoarthritis as the main cause for elective THA surgery, and American Society of Anesthesiologists physical status class 1, which means a normal healthy patient.
- Exclusion criteria included muscular or skeletal disease that might influence the training and physical testing performance, heart or lung diseases, and diabetes mellitus.

Interventions:

- The randomization process was performed by two persons not familiar with the treatment options.
- The STG training sessions were supervised by 2 exercise physiologists with experience from a hospital orthopedic hip joint unit. It was not possible to blind the therapists supervising the maximal strength training intervention, since only the STG group received this training.
- The conventional rehabilitation program for all patients in both groups having inpatient treatment in a rehabilitation center consisted of individual sling exercise therapy in hip

abduction/adduction, hip flexion/extension, exercises with low resistance (>12–15 repetitions), or no resistance, and exercises performed in water when sutures had been removed. Each session lasted 1 hour and was performed 5 days a week for 4 weeks. The patients attended educational classes twice a week. The 2 patients in the CRG who went home after being discharged from the hospital received outpatient treatment supervised by a physician 3 times a week with instructions to carry out prescribed exercises at home 2 times a week.

- In addition to the conventional rehabilitation program, all patients in the STG performed, from 1 week after the operation, 5 training sessions a week for 4 weeks consisting of a 10-minute warmup period performed by stationary cycling. The maximal dynamic strength training consisted of 2 exercises, leg press and hip abduction, that included 4 series of 5 repetition maximum involving the operated leg only. When the patients managed to perform 6 repetition maximum, the load was increased. Leg press was performed in a leg press ergometer in a seated position with a knee joint angle of 90°. Hip abduction was performed using a standard pulling apparatus. The patients were standing in an upright position stabilized by parallel bars with a 15-cm broad sling placed at the medial malleolus of the trained leg. Range of motion was 0° to 25° in the hip joint.
- All patients performed outpatient physical therapy twice a week for 6 months after the inpatient rehabilitation intervention period.
- The outcome assessments and testing were supervised by 2 experienced exercise physiologists.
- All outcome measures were assessed and patients were tested preoperatively, 1 week postoperatively, 5 weeks postoperatively after the rehabilitation training, and 6 and 12 months after THA.

Main outcome measures/Results:

- Three primary outcome variables were included: 1) leg press muscle strength, 2) abduction strength, and 3) work efficiency measured at 3 time points between the 2 studies: 1) 5 weeks postoperatively after the rehabilitation training, 2) 6 months after THA, and 3) 12 months after THA.
    - Both strength tests were measured on both legs, healthy leg, and operated leg and were surrogate measures of walking and ADL function.
        i. Leg press muscle strength
        ii. Hip abduction strength
    - Work efficiency (%), a walking test showing the % of total energy expended
- Secondary outcome variables measured included rate of force development (RFD) (3 parameters), peak force (3 variables), gait patterns (14 parameters), quality of life, and maximum oxygen consumption (6 variables).
- Sample-size estimation calculations were based on detecting strength differences as an expected increase in leg press muscle strength in the operated leg by 20kg after the intervention period, assuming a 2-sided 5% significance level, and 80% power. A sample size of 9 patients per group was determined. Sample size estimates were not based on work efficiency or gait pattern, as this data was not available.
- In the CRG, two patients withdrew from the study before the 12-mo test.
- A *P* value less than .05 was considered as significant for all measurements.

- At baseline (1 week after THA), there was no statistically significant difference between groups for all anthropometric data, for leg press muscle strength in both legs and in the operated leg alone, for hip abduction strength in the operated leg alone, and for work efficiency.
- At the 5-week test after the training intervention, a significant increase was found in leg press muscle strength in both legs and in the operated leg alone for both groups. The improvement in leg press muscle strength was greater in the STG compared with the CRG between 1 week after THA and 5 weeks after THA. After 4 weeks of training, the STG gained 90 kg of muscle strength in both legs compared to a gain of 48 kg in the CRG. After 4 weeks of training, the STG gained 53 kg of muscle strength in the operated leg alone compared to a gain of 28 kg in the CRG.
- At the 5-week test after the training intervention, a significant increase was found in hip abduction strength in the operated leg alone for both groups. The improvement in hip abduction strength was greater in the STG compared with the CRG between 1 week after THA and 5 weeks after THA. After 4 weeks of training, the STG gained 34 kg of hip abduction strength in the operated leg alone compared to a gain of 12 kg in the CRG.
- For between group differences, at 5 weeks after THA, the STG gained more muscle strength and hip abduction strength, and gained it back faster than the CRG.
- There was no statistically significant difference found between groups in leg press muscle strength or hip abduction strength in the operated leg alone at either the 6 or 12 month tests.
- At the 5-week test after the training intervention, no significant difference between the groups was found in work efficiency.
- Work efficiency was significantly improved in the STG compared with the CRG in both the 6 and 12 month tests.

Authors' conclusions:

- The results of this clinical trial demonstrated that it is both appropriate and safe to carry out maximal strength training 1 week after undergoing THA. The main finding in this study is that the STG showed significantly higher performance in leg press, and hip abduction after the 4-week training intervention compared with the CRG, but these differences were not present at the 6 or 12 months tests. Maximal strength training induced a great increase in muscle strength both in leg press and hip abduction in the STG compared with the CRG 5 weeks postoperatively, indicating maximal strength training to be highly effective. Additionally, work efficiency was significantly higher in the STG at 6 and 12 months after undergoing THA compared with the CRG which shows that early postoperative maximal strength training improved work efficiency 6 and 12 months postoperatively compared with conventional rehabilitation. Work efficiency was not higher in the STG at the 5-week follow-up.
- One might expect work efficiency to be significantly improved in the STG compared with the CRG after the intervention period at week 5, reflecting the greater muscle strength in the operated leg in the STG, since several studies report a correlation between increased strength and improved work efficiency. It is also plausible that a longer follow-up period may be necessary to demonstrate a larger effect on work efficiency, and so at 5 weeks the patients may not be able to fully benefit from the gained muscular

strength to increase work efficiency. This seems to be the case, since work efficiency did improve in the STG group at both the 6 and 12 month time points, but not at the 5-week follow-up.

- Initiating the massive strength training as soon as possible after the surgery is of great importance, because major surgery and subsequent hospitalization are known to cause a severe decline in muscle mass and muscle strength.
- The difference in work efficiency between the STG and CRG at 6 and 12 months is an important finding because walking ability is considered one of the most important functional parameters to THA patients. Subjects that have a high work efficiency use less energy and thereby less oxygen for performing a specific task, which is advantageous in many activities of daily life.
- This study indicates that a prolonged maximal strength training program and aerobic endurance training are required to fully recover THA patients.
- This study provides some evidence to support early postoperative maximal strength training in addition to conventional rehabilitation to improve lower extremity muscle strength and work efficiency for THA patients.

Comments:

- Primary outcome measures were not clearly stated. There were too many parameters to measure as outcomes. Eleven parameters were used to measure muscle strength alone.
- A primary outcome measure of pain and function would have added greatly to the interpretation of this study.
- Since both groups received the conventional rehabilitation training, the therapists supervising these sessions could have been blinded to group allocation. However, the authors did not provide this information.
- It is not known if the exercise physiologists supervising the outcome assessments were blinded to group assignment. It is not known if the testing physiologists were the same therapists that supervised the rehabilitation training sessions. If they were not blinded, there is a possible risk that the outcome measures could be inflated.
- Baseline data was not provided in the follow-up article and so this RCT was meaningless without the original article (Husby 2009). Calculations provided in the text results did not match up with the numerical data in the tables. These errors may decrease the level of confidence in the study quality and in the results.
- The authors failed to provide information on the MCIDs for the outcome measures and so it is not known if the gains in leg press muscle strength, abductor strength, and work efficiency are clinically relevant within each group, and if the differences in gains between the groups were clinically significant as well. The normal healthy ranges for the outcome measures were also not provided.
- The RCTs would have been more interpretable if the authors had evaluated the outcome measures in terms of effect sizes, rather than just archaic *P* values.
- After 12 months, work efficiency was only at 16.9% in the STG. Because work efficiency ranges between 20% and 25% on average in healthy people, it is obvious that the patients who received maximal strength training in this study still did not reach the levels of healthy subjects.

- Two of the patients in the CRG had outpatient treatment. The physical outcomes of the 2 patients, however, did not differ from the other participants in the CRG.
- A major strength of this study was the inclusion of a long-term assessment time point at 12 months.
- Similar muscle strength in both groups in the operated leg was expected at the 6 and 12 month tests, because no maintenance strength training program was offered to the STG after termination of the 4 week training intervention.
- The amount of exercise performed after the intervention period was not recorded. Registration of physical activity by the patients from after the intervention period until 12 months might have been of interest to reveal whether the higher work efficiency in the STG at 6 and 12 months was influenced by physical activity or maximal strength training or both.
- Because the participants in this study were younger than 60 years, the results cannot be generalized to all THA patients.
- No description of adverse events was included and the small sample size may impede identifying a small rate of adverse events.
- The study was not powered for between-group differences for all primary outcomes.
- Future studies would benefit from a larger sample size and a longer training period for all the participants. The training duration was relatively short and the sample size extremely small (24 total). A longer duration of the training period (10–12 weeks) followed by aerobic endurance training and a larger sample size may have revealed greater statistical differences between the groups in work efficiency. Limiting the study protocol to a 4-week training program may have impacted the ability of the study to achieve the maximal therapeutic benefit of maximal strength training. This would underestimate the effect of the intervention.

Assessment*:*

This adequate study provides some evidence that adding a 4-week maximal strength training intervention to a conventional hip rehabilitation program in the early postoperative phase after undergoing total hip arthroplasty (THA) is effective in improving lower extremity muscle and hip abductor strength in the short-term (5 weeks post-op), and in improving work efficiency 6 and 12 months after THA better than a conventional hip rehabilitation program alone.