J Rehabil Med 2004; 36: 92–94

Taylor & Francis healthsciences

SHORT COMMUNICATION

A SPECIFIC ARM-INTERVAL EXERCISE PROGRAM COULD IMPROVE THE HEALTH STATUS AND WALKING ABILITY OF ELDERLY PATIENTS AFTER TOTAL HIP ARTHROPLASTY: A PILOT STUDY

Jérôme Maire,[1,2] Anne-Françoise Faillenet-Maire,[3] Céline Grange,[1] Benoit Dugué,[1,4,5] Nicolas Tordi,[1] Bernard Parratte[6] and Jean-Denis Rouillon[1]

From the [1]Laboratoire des Sciences du Sport, Besançon, France, [2]ORTON Orthopaedic Hospital, Foundation for Invalids, Helsinki, Finland, [3]Centre de Réadaptation Fonctionnelle, Service de Rééducation Gériatrique, Quingey, France, [4]Minerva Institute for Medical Research, Helsinki, Finland, [5]EA 2253, Université de Poitiers, France, [6]Service d'Exploration Fonctionnelle Neuro-Musculaire, Centre Hospitalier Universitaire, Besançon, France

***Objective*: To investigate the influence of an arm-interval exercise program for the upper limbs on health status and walking ability in elderly patients after total hip arthroplasty.**

***Design*: A randomized controlled investigation. After surgery, a control group started a general rehabilitation program, and a training group combined it with an arm-interval exercise program.**

***Subjects*: Fourteen patients (age 75.1 ± 4.8 years) were randomly assigned to the control group (*n* = 7) and the training group (*n* = 7).**

***Methods*: A Western Ontario and MacMaster University (WOMAC) Osteoarthritis Index was completed and an incremental exercise test on an arm crank ergometer was also performed 1 month before (T_{-1}) and 2 months after surgery (T_2). Moreover, a 6-minute walk test was performed at T_2.**

***Results*: Both groups significantly improved all dimensions of WOMAC, except in WOMAC physical function subscale in the control group. The training group covered a significantly longer distance in the walking test than the control group and also presented significantly higher $\dot{V}O_2$ peak value at T_2. Correlation analyses indicate that $\dot{V}O_2$ peak value and the distance covered in the 6-minute walking test were significantly associated with functional status. After calculating the ratio distance covered/score at WOMAC physical function, we observed a significantly higher ratio value in the training group than in the control group.**

***Conclusion*: Preliminary results indicate that the improvement in physical fitness and functional status of the training group seems to be associated with better health status.**

Key words: arm exercise, elderly, health status, hip arthroplasty, WOMAC osteoarthritis index.

J Rehabil Med 2004; 36: 92–94

Correspondence address: Jérôme Maire, Laboratoire des Sciences du Sport, Batiment Bichat, Place Saint Jacques, 25030, Besançon Cedex, France. E-mail: jemaire@hotmail.com

Submitted January 31, 2003; Accepted October 15, 2003

INTRODUCTION

After total hip joint arthroplasty (THA), classical post-operative rehabilitation (usually physiotherapy) may not promote patients' maximal recovery. It seems that the rather low amount of daily physical activities carried out by patients after THA leads to deterioration in both exercise capacity and physical condition (1). This situation has strong negative influences on the patients' health status and quality of life. This is especially acute in elderly female patients (>75 years) (2).

We have recently stressed the importance of physical exercise in the rehabilitation process after THA (1, 3). In fact, we have designed a specific, individualized arm-interval exercise program for the upper limbs in elderly patients commencing soon after THA.

In this paper we report the impact of our program on the patients' locomotor performance and health status 2 months after surgery. Studies that simultaneously compare the responsiveness of functional tests and health status of the patients are rare and comparisons of such measurements during the early follow-up period after THA (a period in which the most important changes occur) are even rarer. Therefore, we investigated the influence of an arm-interval exercise program for the upper limbs on health status and walking ability in elderly patients after THA.

METHODS

Subjects and study design

Fourteen elderly patients with osteoarthritis (OA) (12 women and 2 men) undergoing THA were recruited as a convenient sample of volunteers from patients attending the hospital Polyclinique de Franche-Comté, Besançon, France. Only volunteers over 65 years of age, whose main diagnosis was primary hip OA, were included. The patients presented the following characteristics: age 75.1 ± 4.8 years; mass 73.8 ± 13.5 kg; height 158.2 ± 7.9 cm; BMI 29.3 ± 4.7 kg.m^{-2}. Patients were excluded if they were undergoing revision arthroplasties, were unable to sign the informed consent form, had medication which might have interfered with exercise testing and training, and presented pathologies other than OA. Patients performed an incremental exercise test until exhaustion on an arm crank ergometer 1 month before (T_{-1}) and 2 months after surgery (T_2). They also performed a walking test at T_2. After the incremental exercise test, patients were randomly assigned to a training group (TG; *n* = 7, 6 women and 1 man) and to a control group (CG; *n* = 7, 6 women

 ISSN 1650–1977
DOI 10.1080/16501970310021383

and 1 man). Both groups stayed at the rehabilitation centre for 6 weeks, and undertook a traditional daily rehabilitation program based on physiotherapy (muscular strength, range of motion, aquatics, walking; 2 hours per day). In addition, the TG undertook an arm-interval exercise program with an arm ergometer. The study plan was accepted by the local Ethical Committee and all patients signed an informed consent form.

Incremental exercise test with arm ergometer

Patients performed an incremental exercise test on a mechanically-braked arm crank ergometer (Monark Rehab Trainer, Model 881E, Sweden) in a fully-upright sitting position. Respiratory gas exchange was measured with a portable metabolic measurement system cart (Aerosport KB1-C, Aerosport Inc., USA).

Arm-interval exercise program for the upper limbs

The program started 1 week after surgery. It consisted of a 30-minute session, 3 times per week, for 6 weeks. One session consisted of 6 consecutive periods of 5 minutes including 4 minutes of rather low intensity of exercise named "base" work, followed by 1 minute of intense exercise named "peak" work. Initially, the base was set at the ventilatory threshold and the peak at the maximal tolerated power (determined during the progressive test), using the corresponding heart rate (HR) as a target. In order to maintain a sufficient intensity during training, which aimed at reaching a peak HR at the end of sixth period of the peak work, the loads for the base and peak were alternately increased (+5 W). A readjustment was made when the HR at the end of the exercise session was lowered by 10–12 bpm compared with the previous session, or according to subjective feelings.

Health status of the patients

All subjects completed the Western Ontario and MacMaster Universities (WOMAC) Osteoarthritis Index before incremental exercise tests (at T_{-1} and T_2) (4). It was presented in the Likert form, with 24 questions that are divided into 3 separated dimensions: pain (5 items), stiffness (2 items), and physical function (17 items) (5). A high score on the WOMAC questionnaire indicates that the patient perceived a low health status.

Six-minute-walk test

The functional status of the patients was assessed using a 6-minute walking test (6-MWT) performed at T_2. The patient was asked to walk back and forth a 30-metre-long corridor and to cover the longest possible distance in 6 minutes. The outcome measure was the distance walked by the patient in 6 minutes.

Statistics

The data are presented as median and extreme values. The results of the WOMAC and $\dot{V}O_2$ peak are presented as percent of changes. Statistics were performed with the Wilcoxon and Mann-Whitney tests. Relationships between variables were analysed with the Spearman correlation coefficient. The level of statistical significance was set at $p < 0.05$. The sample size calculation regarding the walking test was performed. Using a difference between the groups of 145 metres, a standard deviation of 97 metres, a beta value of 0.80, and an alpha value of 0.05, 7 patients should be a sufficient number of subjects to detect a significant difference at the end of the training program.

RESULTS

Results of incremental exercise test using the arm ergometer

When comparing the changes from T_{-1} to T_2, the difference (% of changes) for $\dot{V}O_2$ peak between TG and CG were significant (+13.5 vs −6.0 %, respectively; $p = 0.036$). Some of the results from the incremental exercise test have recently been presented in detail (3).

Table I. *Changes (median and extreme values in brackets) in the Pain, Stiffness, Physical Function and Global Score of the Western Ontario and MacMaster Universities (WOMAC) Osteoarthritis Index, and the results of the walking test, 2 months after surgery in our training and control groups. Data were analysed using the Wilcoxon and Mann-Whitney tests*

Variables	Control group $n = 7$	Training group $n = 7$
$\dot{V}O_2$ peak	−6.0	+13.5** [a]
(% changes)	(−23.3; 20.6)	(−7.8; 52.0)
Walking test at T_2	259	405[a]
(distance in m)	(218; 302)	(270; 506)
WOMAC – Pain aspects	−72*	−100*
(% changes)	(−100; −60)	(−100; −33)
WOMAC – Stiffness aspects	−75*	−50[a]
(% changes)	(−100; −50)	(−100; 100)
WOMAC – Physical Function	−26	−45*
aspects (% changes)	(−74; 4)	(−65; −9)
WOMAC global scores	−36*	−58*
(% changes)	(−81; −11)	(−72; −21)
Distance covered/score at	11.6	32.5[a]
WOMAC physical function at T_2	(7.8; 22.0)	(15.4; 58.5)

Percentage of changes were calculated as follows:

$$100 \times \frac{[(\text{data obtained 2 months after surgery}) - \text{data obtained before surgery})]}{(\text{data obtained before surgery})}$$

*, **Significantly different from the pre-surgery values at $p < 0.05$ and $p < 0.01$, respectively.
[a]Significantly different from the control group at $p < 0.05$.

Changes in health status

The scores of WOMAC Pain, WOMAC Stiffness, WOMAC Physical Function, and WOMAC Total Score are shown in Table I. Each variable was significantly improved in both groups, except for WOMAC Physical Function Score in CG and WOMAC Stiffness Score in TG. WOMAC Pain Score was significantly improved for TG and CG ($p = 0.003$ and 0.003, respectively). WOMAC Total Score was significantly improved in TG and CG ($p = 0.002$ and $p = 0.027$, respectively). However, WOMAC Physical Function Score was significantly improved in TG only ($p = 0.004$) and WOMAC Stiffness Score was significantly improved in CG ($p = 0.002$) but not in TG. Before surgery, no differences in any of the WOMAC scales were found between the groups, except for WOMAC Stiffness Score ($p = 0.05$). After surgery, we observed a trend for changes between TG and CG for WOMAC Physical Function Score ($p < 0.10$) (Table I).

Result of 6-minute-walk-test

Two months after surgery, the patients in TG walked a significantly longer distance than did the patients in CG ($p = 0.006$; 405 and 259 metres, respectively).

Correlation analyses

Two months after surgery, we found significant correlations between the WOMAC Physical Function vs. $\dot{V}O_2$ peak obtained during incremental maximal exercise test ($p = 0.016$) and also between the WOMAC Physical Function and the distance covered in the 6-MWT ($p = 0.042$). Moreover, after calculating the ratio: distance covered in the 6-MWT/score at the WOMAC Physical Function, we observed a significantly higher ratio in TG than in CG ($p = 0.006$; 32.5 and 11.6, respectively) (Table I).

DISCUSSION

The surprisingly longer distance covered by the TG in the 6-MWT performed 2 months after surgery reflected the most striking outcome of our arm-interval exercise program for the upper limbs. Improvement in $\dot{V}O_2$ peak and in the WOMAC Physical Function were also observed in the TG compared with the CG. It has already been shown that the majority of patients after THA expressed feelings of frustration during the 3–6-month period following the operation (6). Here, we were able to show a significant improvement in health status of our patients for both groups 2 months after surgery. THA itself improves self-reported function in both groups. However, only TG significantly improved the WOMAC Physical Function item after surgery. Moreover, the ratio distance covered in the 6-MWT/score at the WOMAC Physical Function, was significantly higher in TG than in CG. Clearly, the limitations of our study are the relatively small number of subjects and the rather mild difference between the groups in the magnitude of changes in the WOMAC. However, this difference was close to what has recently been presented as the minimal clinically important difference for improvement in patients with OA of the lower extremities (7). Therefore, our results obtained through the functional test 6-MWT and the questionnaire are going hand in hand. However, the magnitude of changes was more impressive in the 6-MWT than in the WOMAC test. Clinical and statistical significance are different concepts and should not be mixed. However, the existence of statistically significant changes in this study prompts one to take a stand over including physical exercise in the development of rehabilitation techniques after THA. Interestingly, after surgery, subjective feelings of patient satisfaction (e.g. WOMAC Physical Function) were significantly correlated with objective benefits (e.g. $\dot{V}O_2$ peak obtained during the incremental exercise test and the distance covered during the 6-MWT). Most of the subjects who experienced an improvement in the $\dot{V}O_2$ peak also reduced their score in WOMAC Physical Function. These subjects were also those who were able to cover the longest distance in the 6-MWT. It may be speculated that the TG would achieve improved possibilities for carrying basic activities in daily living, which would lead to an optimized quality of life and functional independence. Though clear-cut effects of our program are observed in the walking test, the effect on health status is less convincing. Based on this pilot study a larger randomized trial is worthwhile, and based on the sample size calculation using the current effects on the WOMAC and on the work of Angst et al. (7) a larger investigation including 170 patients should be organized. Another important aspect to consider in such investigation is the longitudinal follow-up of the patients. Such studies are of importance to determine whether adding physical training in the standard rehabilitation program is a relevant way to improve physical function and health status of elderly patients after THA.

REFERENCES

1. Maire J, Tordi N, Parratte B, Lonsdorfer J, Rouillon JD. Cardiovascular deconditioning in elderly with hip osteoarthrosis and benefits of reconditioning program after total hip arthroplasty. Review. Sci Sports 2002; 17: 155–165.
2. Espehaug B, Havelin LI, Engesoeter LB, Langeland N, Vollset SE. Patient satisfaction and function after primary and revision total hip replacement. Clin Orthop 1998; 351: 135–148.
3. Maire J, Dugué B, Faillenet-Maire AF, Tordi N, Parratte B, Smolander J, et al. Recovery after total hip joint arthroplasty in elderly patients with osteoarthritis: positive effect of upper limbs interval-training. J Rehabil Med 2003; 35: 174–179.
4. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol 1988; 15: 1833–1840.
5. Roos EM, Roos HP, Lohmander LS. WOMAC Osteoarthritis Index–additional dimensions for use in subjects with post-traumatic osteoarthritis of the knee. Western Ontario and MacMaster Universities. Osteoarthritis Cartilage 1999; 7: 216–221.
6. Pacault-Legendre V, Courpied JP. Survey of patient satisfaction after total arthroplasty of the hip. Int Orthop 1999; 23: 23–30.
7. Angst F, Aeschlimann A, Michel B, Stucki G. Minimal clinical important rehabilitation effects in patients with osteoarthritis of the lower extremities. J Rheumatol 2002; 29: 131–138.