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Effect of pre-operative physiotherapy in patients with end-stage osteoarthritis undergoing hip arthroplasty

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Objective: To examine the effect of pre-operative physiotherapy before hip arthroplasty in patients with end-stage hip osteoarthritis.
Design: A prospective randomized controlled study.
Setting: Physical medicine and rehabilitation and orthopaedic departments of Policlinico Gemelli of Rome.
Subjects: Twenty-three patients randomized in study and control groups.
Intervention: The study group took part in an educational and physiotherapy programme one month before surgery. Both groups took part in the same inpatient rehabilitation programme after surgery.
Main outcome measures: Both groups were evaluated one month (T0) and the day before arthroplasty (T1), after 15 days (T2), four weeks (T3) and three months (T4) post surgery, using the Barthel Index, the Short Form-36 (SF-36), the Western Ontario and McMaster Osteoarthritis Index (WOMAC), the Hip Harris Score (HHS), visual analogue scale (VAS), the British Medical Research Council (BMRC) measures of hip abductor and quadriceps strength and range of hip abduction and external rotation.
Results: There were no significant differences between groups with regard to the Barthel Index, SF-36, WOMAC and HHS at T4. The study group presented significant improvements of the SF-36 physical composite score at T1. The hip external rotation was significantly higher in the study group at each evaluation and the visual analogue scale values were lower at T1, T3 and T4.
Conclusion: Pre-operative physiotherapy in patients undergoing hip arthroplasty does not improve impairment and health-related quality of life after intervention. Physiotherapy and educational therapy may be useful for end-stage osteoarthritis.

Introduction

The effectiveness of physiotherapy programmes after hip replacement surgery is currently confirmed by the literature,[1–3] but many studies analysing the effect of pre-operative physiotherapy in hip joint

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replacement have obtained different results. Gocen *et al*.[4] and Wijgman *et al*.[5] established that pre-operative physical therapy and educational programmes are not useful after hip arthroplasty. Gilbey *et al*.[6] and Wang *et al*.[7] found that the pre-operative exercise group had a faster functional recovery after surgery, with important implications for return to work and reducing the amount of assistance and services required. Rooks *et al*.[8] concluded that pre-surgery exercise programmes can improve the pre-operative functional status and muscle strength levels in people undergoing hip arthroplasty and could reduce the need for inpatient rehabilitation. Spalding[9] analysed pre-operative education programmes by occupational therapists before hip replacement and confirmed that they can reduce patient anxiety. Other authors demonstrated that pre-operative education programmes followed by home-based rehabilitation appeared to be safer and more effective in improving function and health-related quality of life after hip replacement than conventional post-operative treatment in an inpatient rehabilitation unit.[10]

The physiotherapy programmes used in these studies are very varied, including a range of types of exercise, such as cross-training, aerobic or resistance exercises, programmes of cardiovascular, strength and flexibility exercises, and use of fitness machines, such as seated rows, chest presses and leg presses. They also proposed various methods of exercise delivery (group, individual, home-based exercises, water or land-based exercises) associated with a range of educational programmes. The physiotherapy programmes had various durations and different outcome measurements were used.

Current guidelines for the management of patients with osteoarthritis[11,12] recommend the use of therapeutic exercises alone or combined with manual therapy. They confirm the effectiveness of strengthening exercises and general physical activity for the management of pain and functional status improvement. A recent review[13] found that physical training does not seem to provide benefit to patients before hip or knee arthroplasty. However little is known about the effects of a specific physiotherapy programme in patients with end-stage ostheoarthritis (defined according to the diagnosis criteria of the American College of Rheumatology[14]) undergoing hip arthroplasty. The aim of our study is to measure changes in impairment, pain and health-related quality of life in patients with end-stage hip osteoarthritis, pre and post hip replacement surgery, after pre-operative physiotherapy treatment.

Material and methods

Patients

All patients gave their informed consent as approved by the local ethical committee. The patients recruited were affected by end-stage osteoarthritis and were on the waiting list for a total hip replacement surgery in the Orthopaedic Department of the University Hospital 'Agostino Gemelli' of Rome. They were evaluated in the Physical Medicine and Rehabilitation Department of the same hospital between January 2006 and January 2007. The patients were randomized using a table of random numbers. The even numbers were allocated to the control group and the odd numbers to the study group. The patient inclusion criterion was the presence of primary end-stage hip ostheoarthritis. Exclusion criteria were: cognitive deterioration evaluated with a Mini-Mental State Examination[15] (MMSE) $\leq$23, the presence of other joint prosthesis, hip congenital dysplasia, inflammatory arthritis (rheumatoid arthritis, systematic lupus erythematosus), Parkinson's disease and sensitive neuropathy.

Patient assessment

All patients were evaluated one month before surgery (T0), the day before surgery (T1) and up to 15 days (T2), four weeks (T3) and three months (T4) post surgery. Outcome measures were administrated by two research assistants and two physicians, blinded, who had previously been trained in all the outcome tools.

Pre-operative and post-operative treatments were performed by the same physical therapist, who was not blinded.

Outcome measures

Anamnestic and demographic data were reported on a standardized form. This study

examined: (1) muscle strength of hip abductors and quadriceps using the British Medical Research Council (BMRC) scale,[16] (2) range of motion at hip abduction and external rotation, (3) disability, using the Barthel Index (BI),[17] (4) health-related quality of life, using the Short Form-36 (SF-36),[18,19] (5) impairment, using the Western Ontario and McMaster Osteoarthritis Index (WOMAC)[20] and (6) pain evaluation, using a visual analogue scale (VAS).[22]

The SF-36 consists of 36 questions that inquire about the general health status of patients subdivided into eight specific domains of physical and emotional scores which are summarized into two main composite scores: physical composite score the (PCS) and mental composite score (MCS). Very low physical composite scores indicate severe physical dysfunction, severe social and role disability, distressing body pain, frequent tiredness and unfavourable evaluation of general status. Very low mental composite scores indicate frequent psychological distress and severe social and role disability due to emotional problems.

WOMAC was designed and validated to assess activities integral to functional independence in people with osteoarthritis in the limbs and consists of 17 items related to functional status, a five-item pain subscale and a two-item stiffness subscale. The WOMAC function scale is scored from 0 (the best) to 68 (the worst), whereas the WOMAC pain scale is scored from 0 (the best) to 20 (the worst) and the WOMAC stiffness subscale from 0 (best) to 8 (worst).

The Harris Hip Score[21] is a multidimensional observational assessment which contains eight items representing pain, walking function, activities of daily living, and range of motion of the hip joint. Final score ranges from 100 (no disability) to 0 (maximum disability).

Interventions

The exercise protocol was adapted from previous studies about patients with osteoarthritis.[11,12,23–25]

One month prior to surgery the study group took part in a physiotherapy programme consisting of group and individual exercises for five days/week. A physical therapist administrated the sessions for 60 minutes/day. First the patients worked in small groups (maximum three patients) for 40 minutes, then individually for 20 minutes.

The study group also received strength and flexibility training in groups and individually based on: leg stretching, particularly of the hamstrings, hip adductor muscles and hip flexor muscles, and strengthening exercises of the hip abductor muscles and femoral quadriceps. The participants performed 3–4 sets of 8–12 repetitions of single-joint movement and strengthening exercises. They also used the recumbent stationary bicycle for 10–15 minutes of cardiovascular exercise at low or moderate intensity. The study group also received exercises focused on postural realignment of the spine, shoulders, elbows, wrists, hands, hips, knee and ankles. They received advice on the movements that should be avoided, preventing the dislocation of prostheses, the use of devices (crutches, elevated toilet seats, elevated beds and forceps to help in dressing and undressing), correct posture, lifting and carrying, washing and bathing.

The same surgery access and the same prostheses were applied in the study and control groups. A total hip arthroplasty (THA) with an uncemented proximal hydroxyapatite-coated stem (Symax; Stryker-Howmedica, Kalamazoo, MI, USA) was performed. This implant is a titanium straight distal stem with a proximal anatomical shape. Uncemented hydroxyapatite-coated titanium cups were implanted (Trident; Stryker-Howmedica) with ceramic-on-ceramic coupling. All the procedures were performed by two senior surgeons. The posterior approach was used in the lateral position. Accurate soft tissues (posterior capsule and short extra-rotator tendon reconstruction) were performed in all the cases, as described by Pellicci *et al.*[26]

The control group performed exercise only after surgery. The post-surgery inpatient rehabilitation programme in both study and control group patients was performed in our department for four weeks, with a standard protocol of: strengthening progressive exercises of hip muscles, postural and educational nursing, progressive stretching of the hamstrings, hip adductor muscles, walking in progressive weight with crutches and educational programmes as in pre-operative treatment.

Statistical analysis

A statistical analysis was performed using the STAT-SOFT (Oklahoma, USA) package. Because the ordinal and nominal scale values were used, a non-parametric analysis and comparison of the groups was assessed using the Mann–Whitney *U*-test. A within-groups comparison was performed with the Wilcoxon test.

Results

Sixty-three patients on the waiting list for a total hip replacement were evaluated. Twenty-five patients did not meet the inclusion criteria and 15 did not accept the protocol because of problems with daily transport to our department and they believed that the pre-surgery physiotherapy required too much time and would be too tiring. Twenty-three patients were suitable for our study and they were randomized to a study group (11 patients: 4 male, 7 female; mean age 63.82 ± SD 9.01) and a control group (12 patients: 5 male, 7 female; mean age 63.08 ± SD 6.89). Two patients in the control study dropped out, one of them because they refused to be evaluated in the follow-up (three months post surgery) and the other one because of medical issues unrelated to the surgery (Figure 1).

Randomization created similar groups at baseline (Table 1).

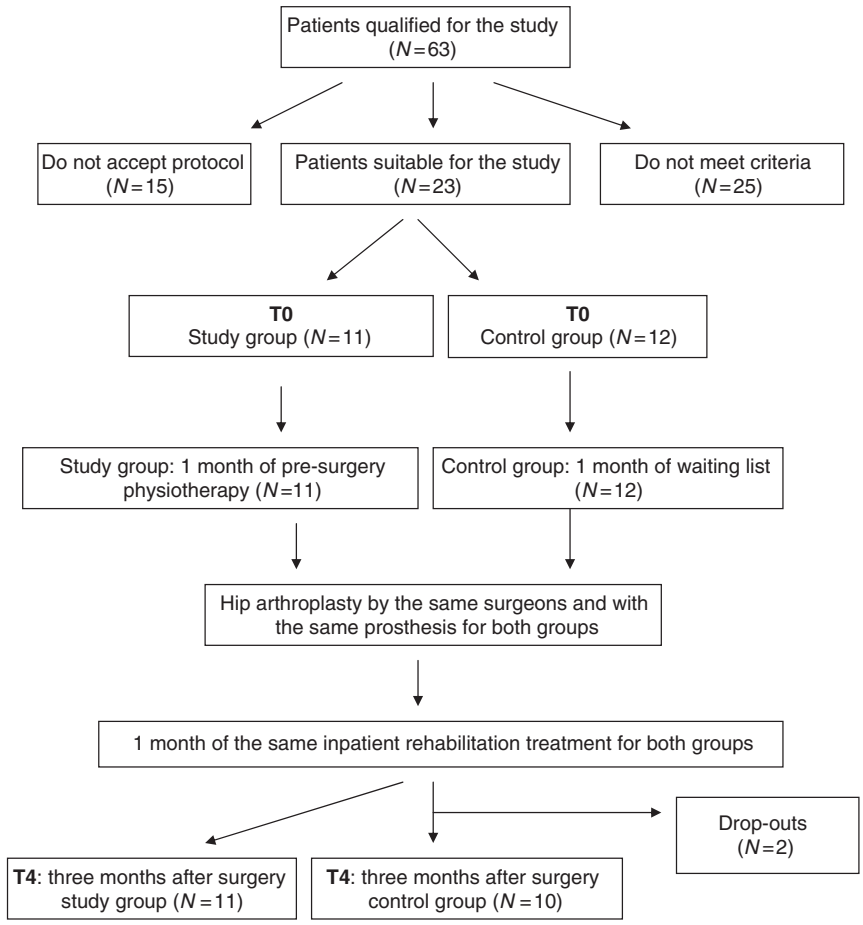

Figure 1 Flowchart of enrolment, randomization and retention results.

As we had predicted, the study group showed significant improvements in hip external rotation ($P = 0.03$), in hip muscle abductor strength ($P = 0.004$), in SF-36 physical composite score ($P = 0.048$) and in visual analogue scale ($P = 0.04$) after one month of pre-surgery physiotherapy (T1) (Table 2).

Table 1 Characteristics of study and control groups at baseline

	Study group $n = 11$	Control group $n = 12$
Female	7/11	7/12
Age	63.82 (9.01)	63.08 (6.89)
WOMAC pain	10.55 (3.88)	11.17 (3.46)
WOMAC function	39.64 (13.69)	44.92 (6.00)
WOMAC stiffness	4.82 (1.88)	4.58 (1.62)
Harris Hip Score	40.89 (13.34)	35.35 (16.21)
Barthel Index	81.8 (7.3)	77.9 (9.6)
VAS	6.92 (1.97)	7.54 (1.80)
SF-36 PCS	31.45 (7.1)	29.75 (8.9)
SF-36 MCS	46.54 (10.3)	43.17 (9.58)
ROM abduction	30.45 (13.12)	32.08 (11.95)
ROM external rotation	15.00 (7.07)	14.58 (7.82)
BMRC quadriceps	4.27 (0.65)	4.25 (0.45)
BMRC hip abductor	4.64 (0.50)	4.42 (0.67)

Values are means and standard deviations (SD).
VAS, visual analogue scale; PCS, physical composite score; MCS, mental composite score; ROM, range of movement; BMRC, British Medical Research Council.

Table 2 Mean and standard deviation between two groups at T1

	Study group $n = 11$	Control group $n = 12$	*P*-value
WOMAC function	33.7 ± 13.8	43.5 ± 9.5	0.63
WOMAC pain	8.0 ± 3.8	11.0 ± 3.6	0.70
WOMAC stiffness	4.82 ± 1.88	4.58 ± 1.62	0.80
Hip Harris Score	43.6 ± 15.7	34.9 ± 15.5	0.24
Barthel Index	84.5 ± 6.7	75.0 ± 16.2	0.60
VAS	5.5 ± 2.2*	7.3 ± 2.0*	0.04
SF-36 PCS	34.4 ± 4.05*	27.3 ± 10.3*	0.048
SF-36 MCS	51.1 ± 11.2	40.9 ± 11.6	1.14
ROM abduction	31.81 ± 10.55	32.08 ± 11.95	0.53
ROM external rotation	22.27 ± 7.86*	14.58 ± 7.82*	0.03
BMRC quadriceps	4.50 ± 0.59	4.25 ± 0.45	0.37
BMRC hip abductor	4.68 ± 0.46	3.90 ± 0.46*	0.004

VAS, visual analogue scale; PCS, physical composite score; MCS, mental composite score; ROM, range of movement; BMRC, British Medical Research Council.
*$P < 0.05$ for between-group.

The range of hip external rotation was significantly higher in the study group at each evaluation and the visual analogue scale values were lower in the study group at T3 and T4 (Figures 2 and 3).

There were no significant differences between the groups at three months after surgery (T4) with regard to Barthel Index, SF-36, Western Ontario and McMaster Osteoarthritis Index and Hip Harris Score. However, there was a significantly lower visual analogue scale ($P = 0.03$) and a higher hip external rotation ($P = 0.02$) in the study group at T4 (Table 3).

Within-group analysis showed, however, a significant improvement in all outcome measures, in both groups, at each assessment.

Discussion

A review of the literature found few studies on the effectiveness of rehabilitation prior to hip surgery. Our study design was very strict. We applied a detailed series of exercises and educational training programmes before the hip arthroplasty, and the same inpatient rehabilitation treatment after surgery. In this way, only the pre-surgery rehabilitation could explain any difference in the results and scores between the two groups. People with hip osteoarthritis show significantly reduced hip strength compared with age-matched controls, and marked muscle atrophy compared with the contralateral hip.[27] The Ottawa Panel evidence-based clinical practice guidelines recommend manual therapy combined with exercise in the management of patients with osteoarthritis.[11] Hence, we created the exercise protocol after a careful evaluation of the studies on osteoarthritis patients.[11,12,23–25] Our exercise protocol was applied to patients with end-stage osteoarthritis.

We confirm that exercise therapy, divided into exercises for joint-specific strength, range of motion and general aerobic conditioning, may be a physiotherapy intervention of choice for osteoarthritis as well as end-stage osteoarthritis.[28] In fact we observed that the study group showed significant improvement in hip external rotation, hip muscle abductor strength and SF-36 physical composite score, as well as a lower visual analogue scale pain score after one month following pre-surgery physiotherapy (T1).

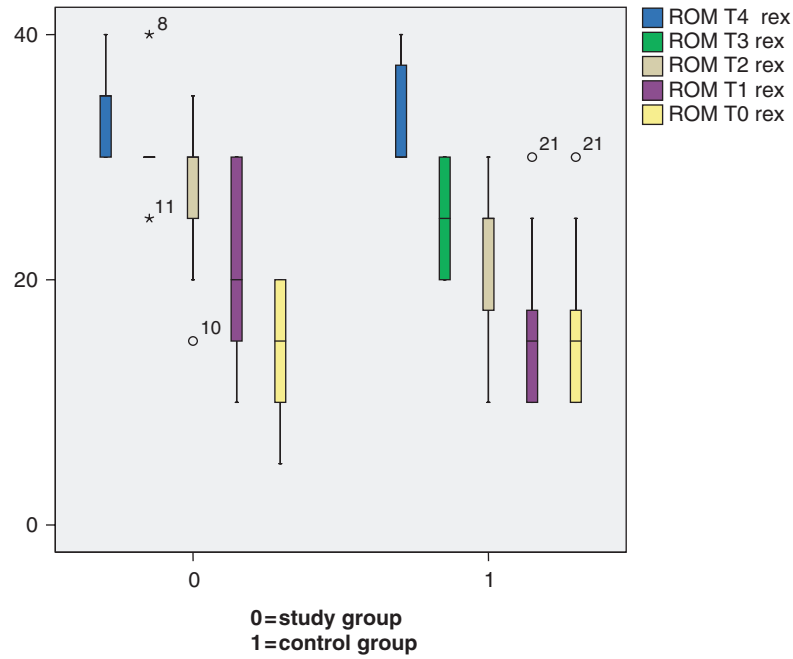

Figure 2 Hip external rotation improvement from T0 to T4.

We support the hypothesis that surgical tissue stress is responsible for the lack of benefit from pre-operative physiotherapy, as proposed by D'Lima *et al.*[29] and Gocen *et al.*[4] In fact we did not find any difference between groups in these scores after surgery.

We observed that the pain scores (visual analogue scale) are significantly lower in the study group in the pre-surgery evaluation (T1), after one month (T3) and up to three months after surgery (T4). The pain measurements evaluated two weeks after the arthroplasty (T2), on the other hand, are similar in both groups for high surgery tissue stress and the presence of post-surgery strain.

Patients with hip ostheoarthritis show poorer physical and social function than population norms for progressive impairments.[30] Analysing health-related quality of life with the SF-36, only in the pre-surgery evaluation (T1) was the physical composite score higher in the study group, indicating less physical dysfunction, less disability, less distressing body pain with a more favourable evaluation of health status after the physiotherapy treatment.

Health-related quality of life was the same at three months after arthroplasty (T4) in both groups. Rooks *et al.*[8] demonstrated similar pre-surgery results. He did not find any significant results in the SF-36 domains at post-surgery follow-up.

There were no significant differences between the groups at three months after surgery (T4) with regard to the Hip Harris Score, in agreement with Gocen *et al.*,[4] and with regard to the Barthel Index, and the Western Ontario and McMaster Osteoarthritis Index, in contrast with the Rooks *et al.*[8] and Gilbey *et al.*[6] results.

We found, however, that the hip external rotation range was significantly higher in the study group at each evaluation and the values of visual analogue scale were lower in the study group between one month and three months post surgery.

We also demonstrated that pre-operative physiotherapy does not change the impairment and

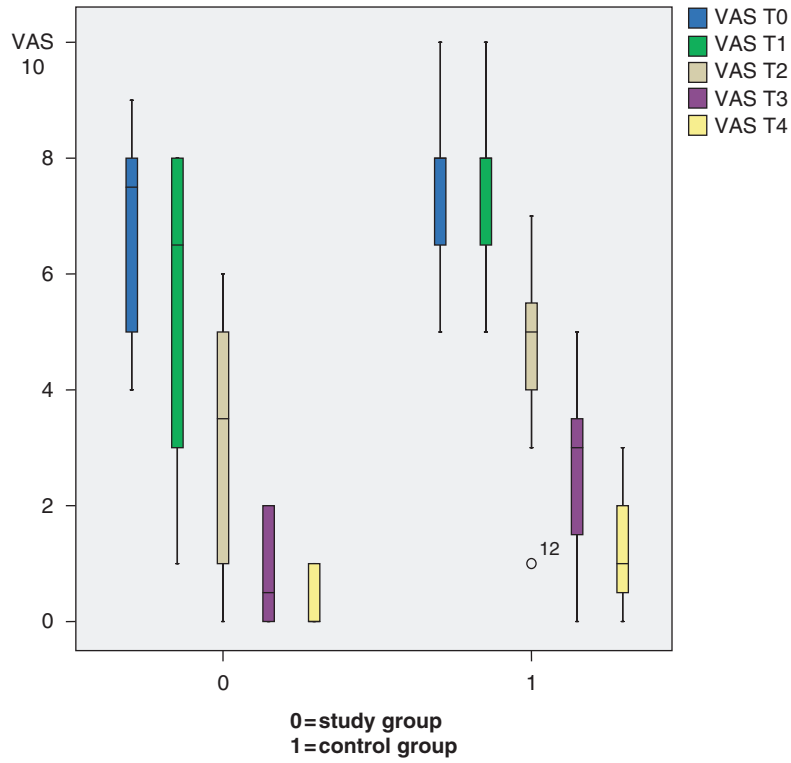

Figure 3 Visual analogue scale improvement from T0 to T4.

Table 3 Mean and standard deviation changes between groups from T0 to T4

	Study group $n=11$		Control group $n=12$	
	T4	Change	T4	Change
WOMAC pain	1.70 (2.35)	−9.1 (4.84)	2.20 (1.75)	−9.0 (4.26)
WOMAC function	18.30 (12.36)	−22 (9.15)	28.5 (10.01)	−16.3 (12.5)
WOMAC stiffness	1.00 (1.33)	−3.9 (2.28)	1.3 (1.56)	−3.3 (1.47)
Harris Hip Score	69.47 (7.49)	28.58 (5.85)	65.2 (15.4)	29.85 (0.81)
Barthel Index	95.00 (4.08)	13 (9.18)	91.82 (2.52)	14.9 (11.7)
VAS	0.30 (0.48)*	−6.8 (1.84)*	1.27 (1.00)*	−6.27 (1.73)
SF-36 PCS	46.60 (8.95)	14.4 (13.14)	52.09 (8.11)	23.0 (9.32)
SF-36 MCS	53.10 (6.65)	6.3 (11.79)	51.36 (9.03)	7.54 (9.74)
ROM abduction	43.00 (6.32)	12.5 (12.74)	39.09 (4.36)	9.09 (10.44)
ROM external rotation	33.50 (4.11)*	18.0 (8.88*)	33.64 (4.52)*	17.72 (5.64)
BMRC quadriceps	5 (0.0)	0.73 (0.46)	5 (0.0)	0.75 (0.62)
BMRC hip abductor	5 (0.0)	0.36 (0.50)	5 (0.0)	0.58 (0.69)

VAS, visual analogue scale; PCS, physical composite score; MCS, mental composite score; ROM, range of movement; BMRC, British Medical Research Council.
*$P<0.05$ for between-group.

health-related quality of life after the operation: both groups showed significant within-group changes after surgery and up to three months after, but few between-group differences.

Our study had some limitations. The number of subjects included was low because the patients with end-stage hip osteoarthritis found it difficult to participate. The pre-operative physiotherapy and educational treatment required considerable cooperation and organization on the part of the patients. Reaching our department for five days/weeks for a month, appeared to be very difficult for end-stage ostheoarthritis patients. Several participants, sedentary and unconditioned, preferred to wait on the waiting list without any outpatient treatment even though they were in pain. We observed that patients with more disabilities presented additional difficulties in reaching our outpatient clinic for pre-operative treatment, and refused care at screening. On the other hand, recent French guidelines[31] have shown that pre-operative multidisciplinary rehabilitation, comprising occupational therapy and education, is desirable among the most fragile patients because of their major disabilities, co-morbidities or social problems. We did not conduct a cost–effectiveness analysis.

It was not possible to blind the physical therapist who carried out the post-surgery inpatient treatment.

The strong point of this study was its randomized controlled design. The clinical evaluations and functional and health-related quality of life measures were administered by a tester who was blinded. Standardized clinical, functional and health-related quality of life measures were used. A specific and 'evidence-based' physiotherapy and educational pre- and post-surgery programme was employed. The pre- and post-surgery programme was practised in a single hospital and by the same therapist. Surgery access and the prostheses and surgeon were the same in all patients. We underline that an identical inpatient rehabilitation programme was performed post surgery in the study and control group patients in our department. This allowed us to exclude the effects of different post-surgery rehabilitation programmes in scores based only on pre-surgery intervention.

Conclusion

We found that pre-operative physiotherapy can improve hip external rotation and reduce hip pain for three months after surgery. This result does not correspond to analogue improvement of impairment and quality of life. The pre-surgery treatment does not significantly reduce the overall post-surgery disability, which, however, improves in an analogous way in both groups after the operation. We confirm current literature data[13] regarding the lack of value of pre-operative physiotherapy and educational programmes to reduce impairment and quality of life after total hip replacement.

Neverthless, one month of intensive physiotherapy gives benefit immediately after treatment, prior to surgery, in end-stage osteoarthritis.

Little is known about the effect of exercise on patients with end-stage ostheoarthritis. We believe that pre-operative exercise intervention could be useful in end-stage hip osteoarthritis as a conservative treatment when surgery is not possible. It will also be necessary to create different pre-operative physiotherapy locations that could allow all patients, some of whom are very frail and disabled, to participate and to carry out other studies.

Clinical messages

- Pre-operative physiotherapy is not useful in patients undergoing hip arthroplasty to reduce impairment and quality of life after the intervention.
- A comprehensive physiotherapy programme and educational therapy is an appropriate conservative treatment for end-stage osteoarthritis to reduce pain.

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Erratum

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The authors of this paper regret that there was an error in the order of the authors listed in the paper. The correct order is published here.

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