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1 Hugo L. Hoeksma, PT, H. Karel Ronday, MD, PhD, Annet Heering, PT, Nico van der Lubbe, PT: Leyenburg Hospital, The Hague, The Netherlands;
2 Joost Dekker, PhD: Institute for Research in Extramural Medicine (EMGO Institute), Vrije Universiteit Medical Center, Amsterdam, The Netherlands;
3 Cees Vel, PT, The Hague, The Netherlands;
4 Ferdinand C. Breedveld, MD, PhD: Leiden University Medical Center, Leiden, The Netherlands;
5 Cornelia H. M. van den Ende, PT, PhD: Netherlands Institute for Health Services Research, Utrecht, The Netherlands.
Address correspondence to Hugo L. Hoeksma, Department of Rehabilitation and Health Services. St. Antonius Hospital, PO Box 2500, 3430 EM Nieuwegein, The Netherlands. E-mail: h.hoeksma@antonius.net.
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Comparison of Manual Therapy and Exercise Therapy in Osteoarthritis of the Hip: A Randomized Clinical Trial

HUGO L. HOEKSMA,1 JOOST DEKKER,2 H. KAREL RONDAY,1 ANNET HEERING,1 NICO VAN DER LUBBE,1 CEES VEL,3 FERDINAND C. BREEDVELD,4 AND CORNELIA H. M. VAN DEN ENDE5

Objective. To determine the effectiveness of a manual therapy program compared with an exercise therapy program in patients with osteoarthritis (OA) of the hip.

Methods. A single-blind, randomized clinical trial of 109 hip OA patients was carried out in the outpatient clinic for physical therapy of a large hospital. The manual therapy program focused on specific manipulations and mobilization of the hip joint. The exercise therapy program focused on active exercises to improve muscle function and joint motion. The treatment period was 5 weeks (9 sessions). The primary outcome was general perceived improvement after treatment. Secondary outcomes included pain, hip function, walking speed, range of motion, and quality of life.

Results. Of 109 patients included in the study, 56 were allocated to manual therapy and 53 to exercise therapy. No major differences were found on baseline characteristics between groups. Success rates (primary outcome) after 5 weeks were 81% in the manual therapy group and 50% in the exercise group (odds ratio 1.92, 95% confidence interval 1.30, 2.60). Furthermore, patients in the manual therapy group had significantly better outcomes on pain, stiffness, hip function, and range of motion. Effects of manual therapy on the improvement of pain, hip function, and range of motion endured after 29 weeks.

Conclusion. The effect of the manual therapy program on hip function is superior to the exercise therapy program in patients with OA of the hip.

INTRODUCTION

Osteoarthritis (OA) is a common cause of disability. OA is characterized by progressive loss and degeneration of articular cartilage, sclerosis of the subschondral bone, and formation of osteophytes (1–3). These changes often lead to pain, loss of mobility and muscle function, restriction in activities of daily living, and decreased quality of life.

In clinical practice, there is a variety of conservative treatment methods available for patients with OA of the hip, including manual therapy and exercise therapy (4). Manual therapy includes manipulation and stretching techniques. Manual therapy is particularly aimed at the improvement of elasticity of the joint capsule and the surrounding muscles (5). Manual therapy is provided by physical therapists (or medical doctors) with a special training in manual therapy. Exercise therapy includes both active and passive exercises (6 –9). Exercise therapy aims at improvement of muscle function, increase of joint range of motion, decrease of pain, and increase of walking ability (6 –9). Exercise therapy is provided by physical therapists.

Exercise therapy is reported to be effective in patients with OA of the hip (8). Both manual therapy and exercise therapy are frequently applied in OA of the hip. It is not known which of these approaches is superior. Therefore, the objective of the present randomized clinical trial was to compare the effects of manual therapy and exercise therapy in OA of the hip.

PATIENTS AND METHODS

Study participants. During the period September 1999 to December 2001, patients with OA of the hip were referred by orthopedic surgeons or rheumatologists to the outpatient clinic of the physical therapy department with complaints due to OA of the hip. Hip OA was defined according to the clinical criteria of the American College of Rheumatology (10). These criteria are hip pain and _15° of internal rotation and _115° of flexion in the hip joint or hip pain and _15° of internal rotation and pain on hip internal rotation and morning stiffness of the hip of _60 minutes. Assessment of the criteria was performed by the referring physician. Exclusion criteria were 1) symptoms in both hips, 2) fear of manipulative therapy, 3) age _60 years or _85 years (to get a maximum spread of 25 years), 4) severe complaints of the lower back, 5) severe cardiopulmonary disease, and 6) insufficient knowledge of the Dutch language to complete instructions and forms. The study was approved by the medical ethics committee of the hospital and all participants provided written informed consent. The study was designed as a single-blind, randomized clinical trial and reported following the CONSORT statement for reporting the results of clinical trials (11).

Randomization. After inclusion in the trial, radiographs of the hip were taken and scored by a radiologist following a standardized procedure according to a modified Kellgren/Lawrence scale (12,13). To optimize prognostic similarity, prestratification was conducted for radiographic severity. Two strata were constructed: stratum 1, Kellgren/Lawrence score _1 (no OA or mild OA); and stratum 2, Kellgren/Lawrence score _2 (moderate or severe OA).

A staff member not involved in the trial prepared the numbered, nontransparent, sealed envelopes. Permutated blocks were used to optimize equal distribution of patients between the 2 intervention groups. A random sequence of permutated blocks of 6 envelopes was generated by using random number tables.

Treatment and measurements. Treatment started within 1 week of baseline. All patients received treatment at the outpatient clinic for physical therapy of the hospital. At baseline, all participants completed a questionnaire containing questions on demographic variables, previous complaints, duration of symptoms, cointerventions, and previous treatment with exercise therapy or manual therapy. The use of medication and other treatment was recorded at each assessment.

Measurements were performed at baseline (week 0), after the treatment period (week 5), and after 3 months (week 17) and 6 months (week 29). General improvement experienced by the patient was assessed only at the 5-week followup visit. This was done because we believe that this measure, due to the long period between the followup measurements (12 weeks), would not be memorized by patients in a correct way. The use of nonsteroidal anti-inflammatory drugs and pain medication prior to the

trial was allowed if it was left unchanged during the study period. Other treatment by health professionals, such as occupational therapists, was to be avoided.

Blinding. A single assessor (HLH), who was blinded to the allocation of treatment programs, carried out all measurements. Patients were instructed by a secretary not to give information about the allocated treatment to the assessor. Furthermore, the assessor was not allowed to visit the physical therapy department during treatment hours to further assure blinding. Also, all measurements were performed at a location separate from the physical therapy department, on a different floor of the hospital. Finally, the assessor was asked to guess the assigned treatment directly after posttreatment measurements (5 weeks).

Interventions. Three manual therapists and 3 physical therapists performed all treatments. The manual therapists were licensed manual therapists. The physical therapists did not receive training in manual therapy or in manipulation techniques. All participating physical therapists were instructed in training sessions. These training sessions were repeated every 3 months. All patients were treated twice weekly for a period of 5 weeks with a total of 9 treatments. The first treatment session was used to tailor the treatment protocol to the individual patient. Content of treatment, deviations from the protocol, and compliance were registered. In addition, adverse effects were registered.

Each manual therapy session started with stretching techniques of identified shortened muscles surrounding the hip joint (Appendix A). Second, traction of the hip joint was performed, followed by traction manipulation in each limited position (a high velocity thrust technique) (14). All manipulations were repeated during each session until the manual therapist concluded optimal results of the session. Both manual therapists working at the hospital and experts in the field of manual therapy were involved in developing the treatment protocol.

In the exercise treatment group, an exercise therapy program was planned by the physical therapist and adjusted to individual symptoms (Appendix B). Exercise therapy included exercises for muscle functions, muscle length, joint mobility, pain relief, and walking ability. Finally, instructions for home exercises were given. The exercise therapy program was an adaptation of the exercise therapy program of Van Baar et al (8,9).

Outcome assessment. The primary outcome measure, general improvement experienced by the patient, was assessed using a 6-point Likert scale ranging from “much worse” to “complete recovery.” This method is often applied as a primary outcome measure in our area of research and has shown to be a valid and reliable assessment (15).

Health-related quality of life was assessed using the Short Form 36 (SF-36) (16). We selected the SF-36 subscales for bodily pain, physical functioning, and role physical functioning.

Hip function was evaluated using the Harris Hip Score and by a walking test (17–20). The Harris Hip Score is a disease-specific index containing 8 items (20). Items represent pain, walking function, activities of daily living, and range of motion of the hip joint. Walking ability was assessed using a walking test. This test was set out in a corridor of the hospital with a marked distance of 10 meters. Total walking distance was 80 meters with 7 turning points. Patients were instructed to walk fast, but not to run. Time to complete the test was recorded (walking speed).

At baseline, all patients were asked to formulate his or her main complaint. The patient then rated the intensity of the main complaint on a visual analog scale (VAS). Also, starting stiffness and pain during the walking test were recorded on a VAS (17,18). Range of hip joint motion from flexion to extension and from internal to external rotation was recorded with a long-legged goniometer according to a standardized procedure (21).

Statistical analysis. The target sample size was 120 patients. This number yields a power of 90% to detect a difference between groups of 30% on the primary outcome measure general improvement at a 2-sided _ of 5%, given a maximum dropout rate of 20%. Enrollment stopped at 109 patients because the actual dropout rate was 6%. The intervention was considered successful if a patient reported to be improved, much improved, or free of complaints.

Analyses were performed according to the intention-totreat principle (22). In addition, a per-protocol analysis was performed excluding patients who had received total hip arthroplasty during the followup period between 5 and 29 weeks. At first, data of the 2 groups were screened for normal distribution using normal plots. Comparison between groups was made for age, sex, severity of OA, duration of complaints, and function (Harris Hip Score). To test between groups on the dichotomized primary outcome measure general improvement, odds ratios (ORs) were calculated. For all continuous variables, analyses were performed with analysis of covariance using the baseline scores as the covariate (with 95% confidence interval [95% CI]). A 2-sided _ of 5% was applied in testing overall significance. In addition, effect sizes were calculated by taking the mean differences of the change scores of the intervention groups and dividing it by the standard deviation of the actual scores of the total population. An effect size of 0.2 is considered small, an effect size of 0.5 is considered moderate, and an effect size of 0.8 is considered large (23).

RESULTS

Comparability. In total, 109 patients were included in the study. The 2 groups were generally similar for baseline characteristics (Table 1); no relevant differences were found. Mean age was relatively high (72 years). Most patients (80%) had a Kellgren/Lawrence score of 2 or 3, indicating moderate to severe OA.

[TABLE 1]

Participant flow and followup. One hundred thirteen patients referred to the physical therapy department were assessed on eligibility (Figure 1). Of the 109 participants, 56 were assigned to the manual therapy program and 53 were assigned to the exercise therapy program. After 5 weeks, 6 patients were lost to followup. After 17 weeks, another 9 patients were lost to followup. At 29 weeks, at total of 21 patients were lost to followup (12 in the manual therapy group and 9 in the exercise therapy group).

[FIGURE 1]

Compliance, cointerventions, and adverse effects. Patients who prematurely discontinued the treatment programs were denoted as noncompliant. Seven patients were considered noncompliant: 3 in the exercise program and 4 in the manual therapy program. In the exercise program, 1 patient withdrew before the first treatment because of traveling distance to the hospital, 2 patients withdrew due to increase of complaints, and 1 patient discontinued because of cardiorespiratory disease. In the manual therapy group, 3 patients discontinued because of increase of complaints. No patients reported to have changed use of medication and no patients reported to have had treatment by other health professionals. No other adverse effects were reported.

Total hip arthroplasty. In total, 18 patients received total hip arthroplasty during the followup period (9 patients in each treatment group). Fourteen patients had the surgery between 5 and 17 weeks followup and 4 patients had the surgery between 17 and 29 weeks followup.

Success of blinding. The outcome assessor reported disclosure of the assigned treatment for 2 patients: in 1 case, a patient dropped the name of the manual therapist and in 1 case, the patient was seen with the physical therapist (exercise therapy group). At 5 weeks followup, the assessor correctly guessed the assigned treatment in 53% of the cases.

Treatment. Exercise therapy was mainly directed toward improvement of muscle function (i.e., strength, endurance, and coordination; 90%), improvement of range of joint motion (82%), and the reduction of pain (74%). The applied exercises were (assisted) active exercises (95%) and passive exercises (72%). In 61% of the patients, home exercise instructions were given. In most cases (90%),

manual therapy was applied according to protocol. However, in 10% (n _ 5) of the cases, manipulations were not used in all treatment sessions.

Outcome. In Table 2 it is shown that after treatment (5 weeks) the success rate (primary outcome) of manual therapy was 81% versus 50% for exercise therapy (OR 1.92, 95% CI 1.30, 2.60). Tables 3 and 4 present the results of the intention-to-treat analysis (including patients who had received total hip arthroplasty). Table 3 presents results for the secondary outcome measures of quality of life and hip function. Beneficial effects of manual therapy on the Harris Hip Score (Figure 2) and walking speed were found. No differences in effects were found on the subscales of the SF-36, except for a beneficial effect of exercise therapy on the subscale role physical functioning. The effect sizes for the Harris Hip Score were large and for walking speed, medium. Table 4 presents the results of the analysis of outcome measures of impairments. Beneficial effects were found for manual therapy on pain, stiffness, and range of motion (Figure 3), effect sizes for pain and stiffness were medium and effect sizes for range of motion were large.

[TABLE 2, 3 AND 4]
[FIGURE 2 AND 3]

The higher improvement in the manual therapy group compared with the exercise therapy group endured for most measures after 17 and 29 weeks. However in general, effects declined as compared with results after 5 weeks. In the per-protocol analysis, similar results were found as in the intention-to-treat analysis (results not reported).

DISCUSSION

Convincing evidence was found for the effectiveness of the manual therapy program as compared with the exercise therapy program in patients with OA of the hip. The effects on general improvement, hip function, and pain were significantly better for patients who were treated with manual therapy. Most of the beneficial effects of manual therapy endured until 3 months and 6 months after finishing treatment.

To our knowledge, this is the first study on the contrast between exercise therapy and manual therapy in OA. The only other available study on manual therapy in patients with OA of the lower extremities is a trial on the effectiveness of a combination of manual therapy and exercise therapy in patients with OA of the knee (5). In that study, beneficial effects were found on pain and function.

We observed a beneficial effect (after 5 weeks) of exercise therapy on the SF-36 subscale role physical functioning. However, in contrast to other findings, this beneficial effect was the only effect in favor of exercise therapy in _10 tested secondary outcome measures on functional ability. Therefore, in our opinion this finding lacks clinical relevance.

High intraarticular pressure, due to restriction of the joint capsule in OA, is associated with pain intensity (1). These pathologic changes lead to reduced range of motion of the hip joint (1–3). Manual therapy (manipulation and stretching) is particularly aimed at the improvement of elasticity of the joint capsule and the surrounding muscles (24,25). It is believed that this results in a reduction of pain and stiffness and an increase of range of motion (3). This could explain the superior effectiveness of manual therapy on pain, stiffness, and range of motion as compared with exercise therapy. However, further research has to be done to specifically determine the mechanism behind the effects of manual therapy on walking ability.

As for the design of the study, some comments can be made. First, the present study was a single-blind study. For obvious reasons, it was not possible to blind either patients or therapists for the allocated treatment. Therefore, extra attention was given to the blinding of the outcome assessor. Second, we cannot exclude the possibility of a placebo effect due to the nature of the interventions. Furthermore, another limitation of the study may be the relatively large number of patients who received total hip arthroplasty during the followup period. However, no differences were found between the conclusions based on the intention-to-treat analysis and the per-protocol analysis.

We chose to standardize the number of treatment sessions to guarantee equal exposure to attention of the physical therapist in both groups. In both groups, all patients received 9 treatments sessions.

Manual therapy is usually applied in a limited number of treatment sessions, because of the expected immediate and relatively strong effects of manual therapy (25). One could argue that the number of sessions in the exercise therapy group was too small to achieve optimal results. In most trials on the effectiveness of exercise therapy, the number of treatment sessions exceeds 9. However, in literature no consensus is reached on the preferred number and frequency of sessions of exercise therapy (9). Furthermore, the exercise therapy protocol that was applied in our trial was an adaptation of the exercise therapy protocol of van Baar et al (8).

The protocol of van Baar was proven to be effective (8,9). When we compared the results of the study of van Baar et al with the outcome in the exercise group in our trial, the results were found to be similar: on general improvement as perceived by the patient, 50% of the patients in our study reported to be improved with exercise therapy versus 47% of the patients in the van Baar study. Therefore, we believe that the exercise protocol that was applied in our study was an effective treatment. We believe that both treatment approaches examined in this trial are common in the treatment of patients with OA of the hip. Manual therapy was performed according to a standardized protocol, which was developed with experts in the field. The protocol of van Baar was also designed to reflect current practice in exercise therapy. This corroborates the external validity of our study.

In conclusion, the experimental group received manual therapy including manipulations and vigorous stretching and the control group received standard exercise therapy, which may have included stretching but did not include manipulation. The manual therapy program was found to be superior to the exercise therapy program. Furthermore, the effects of the manual therapy program lasted up to 6 months after the end of therapy. Thus, in patients with OA of the hip, manual therapy seems to be a suitable treatment option.

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APPENDIX A: MANUAL THERAPY IN OSTEOARTHRITIS OF THE HIP: A PROTOCOL

Developed by the Department of Physical Therapy, Leyenburg Hospital and the Netherlands Institute for Health Services Research

Frequency of sessions and duration of episode

The duration of a session is 25 minutes. The frequency is twice a week at a total of 9 treatments.

Treatment protocol

Manual therapy (manipulation and stretching) is particularly aimed at the improvement of elasticity of the joint capsule and the surrounding muscles.

Muscle stretching. Muscle stretching is an integrated part of the manual therapy program. Each session starts with stretching of shortened muscles. The following muscle (groups) are stretched: m. iliopsoas, m. quadriceps femoris, m. tensor fascia latae, m. sartorius, m.m. adductors and m. gracilis (1). Starting posture is a supine position. The patient has to experience a stretching sensation. Actual stretching is applied for 8 to 10 seconds. Repeat stretching of each muscle (group) 2 times. Total time: 10–15 minutes.

Manipulation. Manipulation is performed according to a traction manipulation technique (2). The therapist's hands are placed just above the ankle joint. All manipulations are performed in slight abduction to avoid slamming of the femoral head into the acetabular surface. The first traction manipulation is performed in the maximum loosed packed position of the hip joint (2). With each following manipulation, the hip joint is placed in a more limited position (which differs per patient). In total, a maximum of 5 manipulations can be applied. The final manipulation is performed in the most limited position of the hip joint. In between manipulations, active assisted motions of the hip joint are performed for relaxation.

To evaluate the success of manipulation, after each manipulation "end feel" of the hip joint is tested using a traction test and by passive hip flexion. This is compared with the contralateral hip. When end feel of the treated hip is similar to the contralateral hip, optimal result is concluded.

Patient education and advice. The promotion of physical activities in general is of importance. Main goal is to couple improvement in joint function with physical activities, such as walking, cycling, and swimming. Furthermore, instruction about load ability of the hip joint has to be provided.

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APPENDIX B: EXERCISE THERAPY IN OSTEOARTHRITIS OF THE HIP: A PROTOCOL

Developed by the Department of Physical Therapy, Leyenburg Hospital and the Netherlands Institute for Health Services Research

Introduction

This is a summary of the exercise protocol. The protocol is an adaptation of the protocol of Van Baar et al (1). In addition, the book of Evjenth and Hamberg is followed on muscle stretching techniques (2). All participating physical therapists are instructed in training sessions. These training sessions will be repeated every 3 months.

Frequency of sessions and duration of episode

The duration of a session is 25 minutes. The frequency is twice a week at a total of 9 treatments.

Treatment protocol

The exercise program is tailored to the individual patient's needs by the therapist. The first session is used to compile exercise therapy treatment goals by questioning, physical examination, and observation of walking ability. It is of great importance to identify specific impairments and disabilities that are of high priority to the patient.

There are 4 main treatment goals on which exercise therapy focuses: 1) increase of muscle function, including endurance, strength, and coordination; 2) improvement of range of motion; 3) decrease of pain; and 4) improvement of walking ability. Furthermore, education and advice need to be provided to the patient.

Muscle function. Mainly active exercises have to be applied to improve muscle function. Exercises consist of muscle strengthening exercises with the use of weight or strengthening equipment. Endurance is trained by walking on a treadmill or cycling on a home trainer. Finally, coordination is trained through walking exercises with increased complexity and through balancing exercises.

Range of motion. If regarded necessary, range of joint motion can be increased through both passive and active exercises. Active exercises should have the upper hand.

Active exercises consist of 3-dimensional motions of the hip joint that go beyond the range of joint motion that most patients use in activities of daily living. These exercises can be performed in weight-bearing and non–weight-bearing positions. In addition, these exercises can be applied in different positions, such as during standing, sitting on a chair, and while lying down.

Passive exercises contain passive movement of the hip and stretching exercises according to Evjenth and Hamberg. Postures and starting positions for stretching exercises can be found in the book of Evjenth and Hamberg (2).

Pain. If regarded necessary, exercises for pain relief can be applied. Pain relief is also achieved through active joint motion exercises and through stretching exercises. In addition, second and third degree traction in the maximum loosed packed position of the hip can be applied (2).

Walking ability. Walking ability is trained by specific walking exercises with adjustment of gait pattern, use of walking aids, and instruction on climbing of stairs.

Patient education, advice, and home exercises. The promotion of exercise in general is of great importance; such activities as walking, cycling, and swimming are recommended. Concerning home management and social activities, these are specifically focused to take an active approach to pain, instead of taking rest and sitting down. Avoidance of prolonged static load and instruction on load

ability of the hip should be emphasized. Instructions for home exercises, derived from the specific exercises as performed during the treatment sessions, are provided.

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TABLES AND FIGURES

Table 1. Baseline characteristics (n = 109)*

	Manual therapy	Exercise therapy
Total no. patients	56	53
Females/males, no.	38/18	38/15
Age, mean ± SD years	72 ± 7	71 ± 6
Duration of complaints		
1 month to 1 year	22	15
1 year to 2 years	12	13
2 years to 5 years	9	15
5 years to 10 years	10	8
Longer than 10 years	3	2
Medication		
No medication	41	38
Analgetics or NSAIDs	15	15
Previous treatment		
Massage	2	3
Exercise therapy	3	2
Manual therapy	0	1
Radiographic deterioration		
0 (no OA)	5	4
1 (mild OA)	7	6
2 (moderate OA)	19	23
3 (severe OA)	25	20
Main complaint, no.		
Pain	34	33
Morning stiffness	5	4
Starting stiffness	4	3
Walking disability	13	14
Harris hip score, mean ± SD	54 ± 15	53 ± 14

* Data presented are means, unless otherwise noted. Radiographic deterioration, according to modified Kellgren and Lawrence scale. NSAIDs = nonsteroidal antiinflammatory drugs; OA = osteoarthritis.

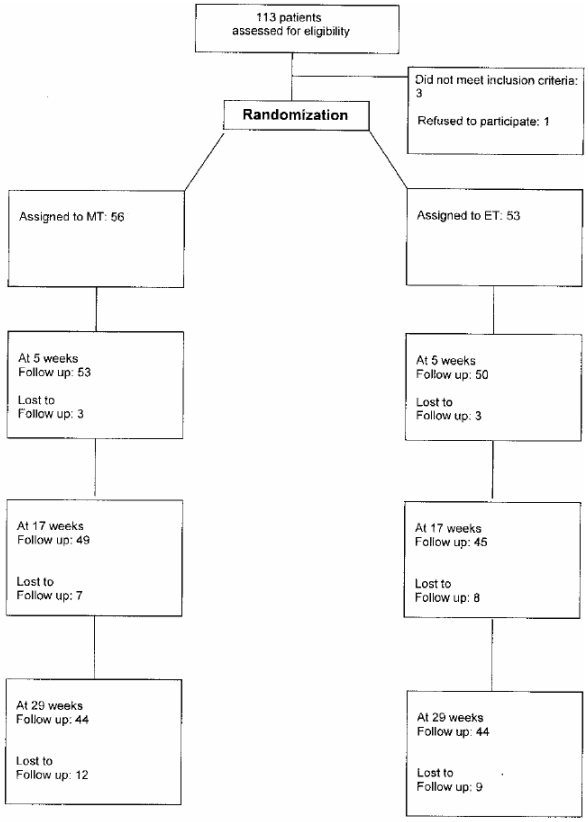

Figure 1. Patient flow and followup. MT = manual therapy; ET = exercise therapy.

Table 2. Differences between the 2 treatment groups after 5 weeks*

	Manual therapy	Exercise therapy	Main comp exercise therapy	Main comp manual therapy	Kellgren and Lawrence 0	1	2	3	Odds ratio	95% CI
Worse	3	6	10 ± 15	23 ± 18	0	2	3	4		
Little worse	2	3	1 ± 8	22 ± 19	1	1	2	1		
Stable	5	16	4 ± 12	4 ± 12	2	0	6	13		
Improved	27	21	−12 ± 14	−20 ± 14	4	7	20	17		
Much improved	15	4	−34 ± 24	−35 ± 17	2	2	10	5		
Free of complaints	1	0	−18		0	0	1	0		
Improved (%)	43 (81)	25 (50)							1.92	1.30, 2.60
Not improved	10	25								

* Improvement of the main complaint (main comp.; visual analog scale, analysis of covariance) on the basis of primary outcome; negative numbers indicate improvement. Primary outcome on the basis of Kellgren and Lawrence. Odds ratio for improvement of manual therapy versus exercise therapy. 95% CI = 95% confidence interval.

Table 3. Quality of life and hip function*

	Manual therapy		Exercise therapy				
	No.	Score	No.	Score	Mean differences†	95% CI	Effect size
SF-36 bodily pain							
Baseline	56	41.1 ± 18	53	37.9 ± 18			
Week 5	53	44.0 ± 17	50	42.4 ± 17	−2.1	−4.4, 8.6	0.1
Week 17	49	47.4 ± 25	45	46.1 ± 20	−3.2	−13.1, 6.8	0.1
Week 29	44	51.4 ± 22	44	49.9 ± 24	−1.5	−11.1, 7.7	0.1
SF-36 physical function							
Baseline	56	42.1 ± 23	53	41.4 ± 21			
Week 5	53	43.6 ± 18	50	41.5 ± 22	1.4	−4.7, 7.4	0.1
Week 17	49	45.3 ± 23	45	46.6 ± 21	−2.1	−11.7, 7.7	0.1
Week 29	44	50.4 ± 22	44	45.3 ± 18	3.1	−4.1, 10.5	0.2
SF-36 role physical function							
Baseline	56	27.0 ± 38	53	24.7 ± 36			
Week 5	53	23.2 ± 30	50	32.2 ± 24	−11.3	−21.5, −1.1‡	0.4
Week 17	49	25.4 ± 43	45	29.8 ± 33	−6.4	−23.5, 10.2	0.2
Week 29	44	36.7 ± 44	44	32.4 ± 35	2.2	−16.8, 21.1	0.1
Harris hip score							
Baseline	56	54.0 ± 15	53	53.1 ± 14			
Week 5	53	69.3 ± 15	50	57.2 ± 11	11.2	6.1, 16.3‡	0.9
Week 17	49	68.4 ± 17	45	56.0 ± 15	11.1	4.0, 18.6‡	0.7
Week 29	44	70.2 ± 20	44	59.7 ± 18	9.7	1.5, 17.9‡	0.5
Walking speed (seconds)							
Baseline	56	96.3 ± 37	53	96.1 ± 25			
Week 5	53	88.3 ± 23	50	96.5 ± 27	−8.2	−16.7, −0.5‡	0.3
Week 17	49	86.8 ± 27	45	99.4 ± 21	−12.7	−24.0, −2.0‡	0.5
Week 29	44	90.5 ± 26	44	102.8 ± 18	−12.1	−20.5, 3.8	0.6

* Data presented as mean scores ± SDs per group. Mean differences adjusted for baseline values as analyzed by analysis of covariance. On Short Form 36 (SF-36) subscales and Harris hip score, positive signs indicate improvement. On walking speed, negative signs indicate improvement. 95% CI = 95% confidence interval.
† Adjusted for baseline values.
‡ $P < 0.05$.

Table 4. Pain, stiffness, and range of joint motion*

	Manual therapy		Exercise therapy				
	No.	Score	No.	Score	Mean differences†	95% CI	Effect size
Pain at rest, VAS, mm							
Baseline	56	22.5 ± 23	53	23.0 ± 26			
Week 5	53	17.1 ± 22	50	26.7 ± 18	−9.1	−16.4, −1.6‡	0.5
Week 17	49	19.1 ± 29	45	26.9 ± 28	−7.2	−13.8, −0.5‡	0.3
Week 29	45	14.0 ± 27	44	21.6 ± 30	−7.0	−20.3, 5.9	0.3
Pain walking, VAS, mm							
Baseline	56	34.0 ± 22	53	28.8 ± 22			
Week 5	53	22.8 ± 21	50	27.1 ± 21	−9.6	−17.3, −1.8‡	0.5
Week 17	49	16.4 ± 26	45	23.7 ± 21	−12.1	−22.9, −2.5‡	0.5
Week 29	44	17.0 ± 22	44	24.3 ± 28	−12.7	−24.0, −1.9‡	0.5
Main complaint, VAS, mm							
Baseline	56	55.2 ± 22	53	56.1 ± 21			
Week 5	53	37.7 ± 22	50	50.2 ± 22	−11.7	−20.4, −2.7‡	0.5
Week 17	49	38.5 ± 22	45	53.0 ± 26	−13.0	−22.5, −2.8‡	0.5
Week 29	44	35.6 ± 22	44	49.1 ± 30	−12.8	−26.5, 1.8	0.5
Starting stiffness, VAS, mm							
Baseline	56	51.2 ± 28	53	46.8 ± 28			
Week 5	53	33.3 ± 25	50	41.3 ± 29	−12.1	−23.5, −2.8‡	0.5
Week 17	49	32.9 ± 33	45	43.0 ± 32	−14.0	−28.1, −0.6‡	0.4
Week 29	44	44.3 ± 26	44	44.8 ± 30	−4.8	−17.5, 7.7	0.2
ROM, degrees, flex–ext							
Baseline	56	101.3 ± 20	53	100.0 ± 30			
Week 5	53	115.8 ± 10	50	98.7 ± 23	16.0	8.1, 22.6‡	1.0
Week 17	49	116.5 ± 13	45	104.4 ± 11	10.7	5.6, 15.2‡	0.9
Week 29	44	114.3 ± 14	44	104.5 ± 13	8.1	2.7, 13.1‡	0.6
ROM, degrees exter–inter							
Baseline	56	32.1 ± 18	53	27.8 ± 20			
Week 5	53	45.5 ± 11	50	29.0 ± 15	12.1	6.1, 17.3‡	0.9
Week 17	49	43.1 ± 14	45	32.0 ± 12	6.5	−5.4, 18.9	0.5
Week 29	44	39.4 ± 14	44	30.6 ± 12	2.8	−1.1, 7.1	0.2

* Mean scores ± SDs per group. Mean differences adjusted for baseline values as analyzed by analysis of covariance. On visual analog scales (VASs), negative signs indicate improvement. On range of motion (ROM), positive signs indicate improvement. 95% CI = 95% confidence interval; flex = flexon; ext = extension; exter = external rotation; inter = internal rotation.
† Adjusted for baseline values.
‡ $P < 0.05$.

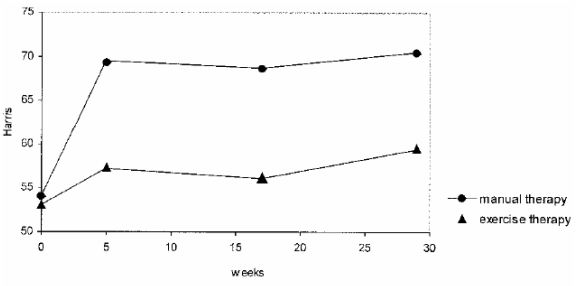

Figure 2. Results of the Harris Hip Score.

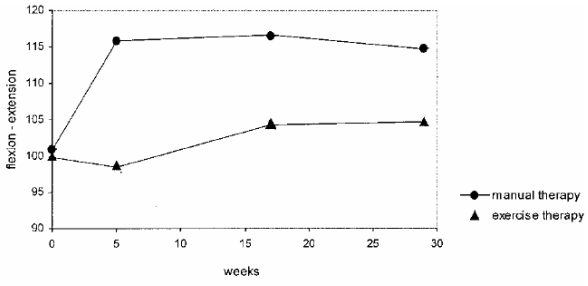

Figure 3. Results on range of joint motion from flexion to extension.