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EFFECT OF PREOPERATIVE PHYSIOTHERAPY IN UNICOMPARTMENTAL PROSTHETIC KNEE REPLACEMENT

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ABSTRACT. The purpose of this study was to analyse the effects of preoperative physiotherapy on pain and function in 39 patients scheduled for unicompartmental prosthetic knee replacement. Nineteen patients were selected at random to receive preoperative physiotherapy. The control group received no preoperative therapy. Evaluations were performed 3 months prior to surgery, immediately before and 3 months after operation. Evaluations included: Clinical assessment, measurements of the knee muscle strength, self-selected walking speed and the oxygen cost of walking. Three months before surgery the patients in both groups had similar types and levels of problems. Before surgery patients who had received physiotherapy showed slight improvements in pain, perceived stability of the knee during walking, and faster self-selected and maximal walking speeds compared to the control group, but were unchanged in muscle strength, ROM, and oxygen cost. Three months after surgery pain was significantly decreased in all patients, however, no significant differences were found between the two groups for any variable except muscle strength. This was unchanged compared to preoperative values for patients of the control group while patients who received preoperative physiotherapy showed a decrease in strength. In summary, this study did not disclose any major benefit from the program of preoperative physiotherapy tested.

Key words: arthroplasty, knee, muscle strength, osteoarthrosis, oxygen consumption, pain, physiotherapy, surgery.

In clinical practice physiotherapy is often used as a treatment in patients with osteoarthrosis of the knee. Short-wave diathermy, mobilizing, strengthening and stabilizing exercises, co-ordination training, isometric quadriceps training and functional walking training are examples of such treatment. The treatment can either be given on an individual basis or as instructions to a group of patients at the same time. In some previous studies, attempts have been made to evaluate the effect of physiotherapy in patients with osteoarthrosis (7, 8, 10, 13, 16, 20). Among these studies, in which various forms of physiotherapy often are combined with anti-inflammatory drug treatment and social service help, there is only one study in which a control group has been used for comparison (7). In this latter study the authors did not find any significant treatment effect. In another study, Lankhorst et al. (8) has compared short-wave diathermy with an individually tailored exercise program consisting of elements of mobilizing, strengthening and stabilizing exercises, co-ordination training and functional walking training in patients with knee osteoarthrosis but they did not find any significant difference between the groups. To our knowledge there is no report in the literature on the effect of physiotherapy before and after surgery in patients with osteoarthrosis of the knee. A rapid rehabilitation mostly is to be preferred in these elderly patients. Whether a specified preoperative group program, with interest focused on walking capacity and muscle strength in the lower limb, would be enough to improve postoperative values seems important to find out.

The purpose of this study was to analyse the effects of preoperative physiotherapy, as specified below, on pain and function in patients with medial moderate osteoarthrosis of the knee and undergoing unicompartmental prosthetic knee replacement.

MATERIAL AND METHODS

Forty patients, 20 women and 20 men, with moderate medial osteoarthrosis of the knee and generally free from clinical symptoms from other joints in the lower extremities were included in the present study. All patients were scheduled for unicompartmental replacement of the knee with a cemented Brigham

Table I. *Patient data. Mean values ± SD. Distribution of patients in respect to the grade of osteoarthrosis*

	Age (year)	Height (cm)	Body mass (kg)	Grade of osteoarthrosis		
				I	II	III
Treatment group ($n=19$)	64 ± 4	172 ± 8	89 ± 14	3	7	9
Control group ($n=20$)	63 ± 5	171 ± 8	85 ± 14	5	6	9

endoprosthesis. The main indication for surgery was pain in the knee.

Twenty patients (the treatment group) were chosen at random, by drawing of lots, for preoperative physiotherapy, and 20 patients (the control group) for no preoperative physiotherapy.

In the treatment group one man had a heart attack and could not complete the treatment. The treatment group was subsequently composed of 11 women and 8 men. The osteoarthrosis of the knee was classified and graded (Table I) according to Ahlbäck (1). Two patients had symptoms of bilateral knee osteoarthrosis.

The control group included 9 women and 11 men. Three patients had symptoms of bilateral knee osteoarthrosis. The characteristics of the patients are sufficient in the two groups, and summarized in Table I.

Patients with bilateral knee osteoarthrosis were included in the study provided that the clinical symptoms of the knee osteoarthrosis during walking were due to only one knee, i.e. the knee scheduled for surgery. There was no difference between the groups in use of anti-inflammatory drugs, and before surgery there were no changes of medication.

Examinations

All patients were examined three times; 3 months prior to surgery (test A), immediately before surgery (test B), and 3 months after surgery (test C).

Clinical examination. The clinical examination was focused on pain, range of motion (ROM) and perceived stability of the knee. Pain was assessed with a four-graded scale (no, mild, moderate, and severe pain). Passive range of motion (ROM) was measured with a short lever arm goniometer by one physiotherapist who was not involved in the treatment of the patients. Stability of the knee joint was assessed as stable or unstable both by the patient himself and by clinical examination i.e. no sagittal instability and no coronal instability of more than 10° at provocation compared to the contralateral knee joint.

Muscle strength. Muscle strength was measured isokinetically with a Cybex II dynamometer (Cybex Div. of Lumex, Inc, 2100 Smithtown Ave, Ronkonkoma, NY 11779) and tests were performed according to previous descriptions (5, 18, 21). Strength of the knee extensor and flexor muscles was measured in the limb scheduled for surgery. Torque was adjusted for the weight of the lower limb. The peak torque value, the angle for the peak torque value, and the torque values at 30° and 60° of knee flexion were recorded at two angle velocities, 30° and 90° per second. To ensure that the maximum effort was recorded in the tests, the tests were repeated. Torque curves were accepted only when three repeated tests gave almost identical results.

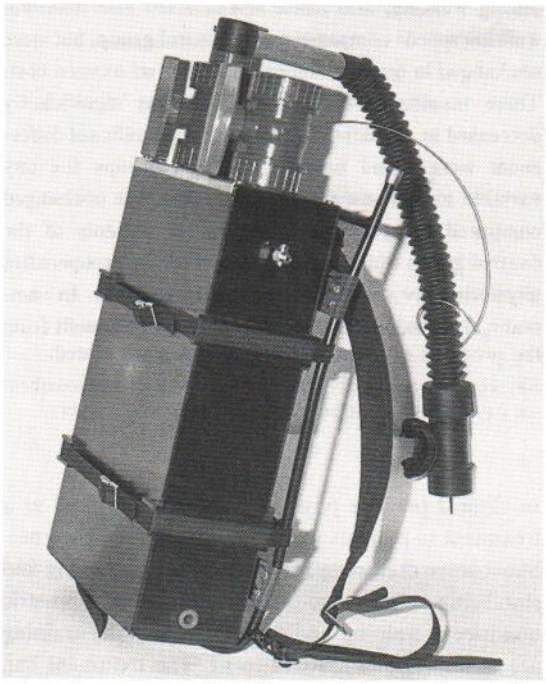

Fig. 1. Photograph of the light-weight backpack carried by the patient during the walk test.

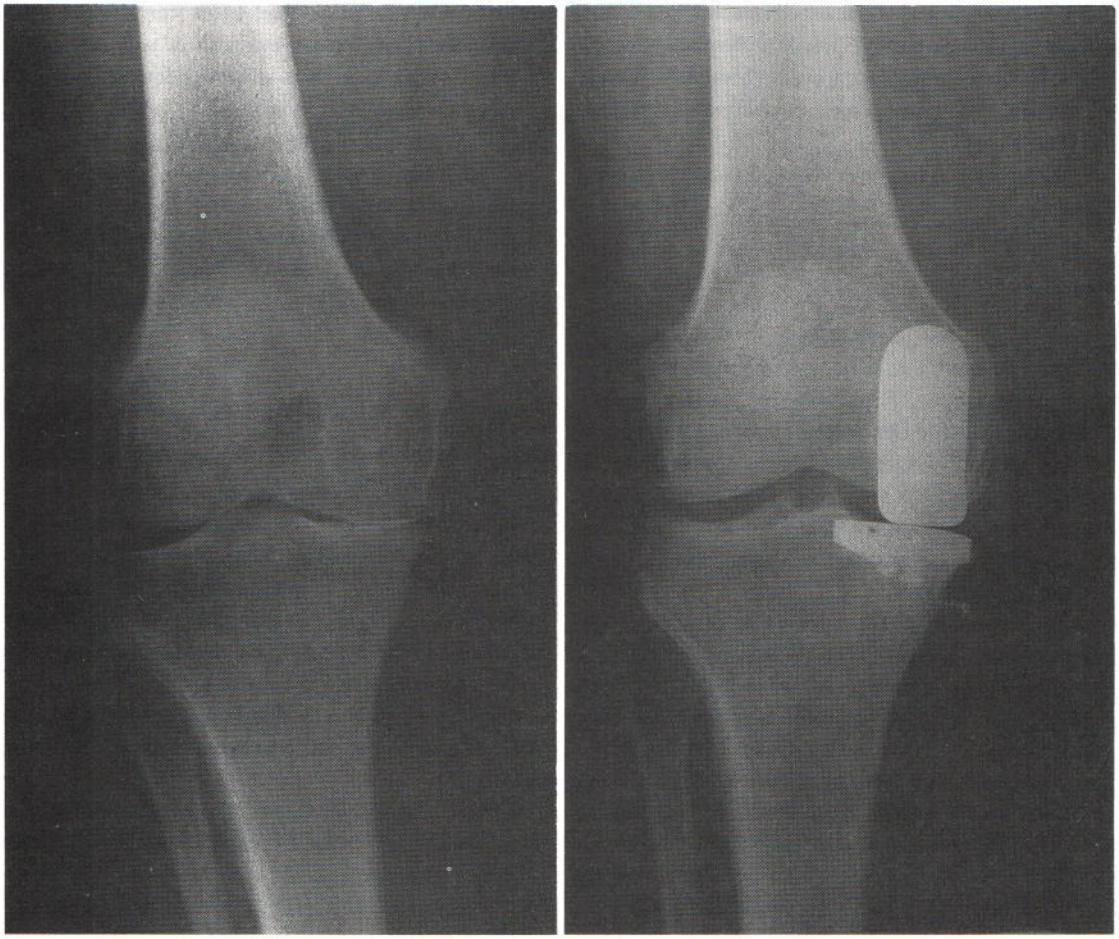

Fig. 2. Radiographs of the knee joint with moderate medial osteoarthrosis of the knee before and after replacement with a cemented Brigham unicompartmental endoprosthesis.

The peak torque value was calculated as the average value of the 3 highest out of all 18 values recorded of each torque curve. The Cybex dynamometer used was tested by Gransberg & Knutsson (5) in 62 healthy volunteers and was found to measure the torque produced by muscle contraction with a relevant degree of precision at constant speeds of angular rotation up to 300°/s (5). The flexion/extension ratio (18, 19), i.e. the ratio between peak torque value for the knee flexors (the hamstrings muscles) and the knee extensors (the quadriceps muscles), was calculated.

Walking capacity. Walking tests were performed indoors according to a method previously described (11). With this method oxygen cost of floor walking can be determined with high accuracy, the coefficient of variation was less than 3%. During the walking test the patient wore a light-weight box (3.5 kg, 10 litres) on his back (Fig. 1). The patient wore a nose clip and breathed through a mouthpiece, connected to the box with a flexible low-resistance host. Argon gas with a constant, well-defined flow was added at the inlet of the box. With this method only a small sample (200 ml) of the gas mixture from the box was needed for analysis of ventilation and oxygen uptake in a mass spectrometer (11).

Walking speed was determined by a speedometer, which was pushed along-side the patient. The patients were asked to walk at their most comfortable speed and at their maximal speed at all tests. At retests, walking tests were also performed at a third speed, i.e. the speed that was selected as comfortable at the start (test A) of the study. To achieve the predetermined

speed the patient was guided by the test leader, who walked beside the patient pushing the speedometer. Duplicated tests of walking speed determined with this method showed high accuracy, coefficient of variation less than 1% (11).

Pain during walking was assessed using 10-graded scale (4).

Treatment

Physiotherapy. The patients in the treatment group were given a fixed, prescribed preoperative treatment by a physiotherapist. The aim of the treatment was to preserve or improve the range of knee motion and to increase strength of the knee extensor and flexor muscles. The patients were treated in groups of 3–4 patients three times a week for a total of 15 times. The patients were recommended to practice the same program at home every day.

Each session of the preoperative physiotherapy treatment consisted of: (*i*) Warming up on an unloaded bicycle ergometer for 10 minutes in a speed of 50 turns/minute; (*ii*) Mobility exercises of the knee joint. The patient exercised both in a sitting and a supine position, five times of extension and five times of flexion movements in both positions; (*iii*) Muscle strengthening exercises of the whole limb. The patient exercised lying, sitting, and standing. The extremity was lifted unloaded against gravitation and was kept in lifted horizontal position for 10 seconds. The knee extensors were also trained with the leg loaded at the ankle with 1–3 kg (weight depending on pain).

Every movement was repeated 20 times with a short break after 10 times. The control group did not receive any preoperative treatment.

Surgery. Three months after commencement of the study all patients underwent a knee arthrotomy and the medial knee compartment was replaced by a Brigham unicompartmental endoprosthesis (Fig. 2) (17). A parapatellar skin and retinacular incision was used. Femoral and tibial components were cemented in position with soft tissue tightening and any varus deformity was corrected. Weight bearing and active exercises were started on the first postoperative day and all 39 patients had the same postoperative training twice a week, in all ten times, and were recommended to perform the same training as a home-program.

Statistics. Mean and standard deviation (SD) are used to present data. Interindividual changes in pain, ROM and pain during walking were tested with a two-tailed Wilcoxon's matched-pairs signed ranks test. Interindividual changes in stability were calculated using Fisher's exact test. Comparisons between the groups on each examination were performed using Mann-Whitney's U-test (two-tailed) for pain, ROM and pain during walking, and Fisher's exact test for stability. Statistic evaluation using a two-tailed Student's *t*-test was performed on the isokinetic torque measurements, the walking speeds, and the oxygen cost of level walking. $p < 0.01$ was chosen as the level of significance.

RESULTS

Clinical examination

Pain (Table II). At commencement of the study most of the patients had moderate or severe pain. There were 8 patients in the treatment group and 5 patients in the control group who graded the pain as severe. After preoperative physiotherapy, pain was significantly decreased in the patients in the treatment group. There were no changes in the control group. Three months after surgery pain was significantly reduced in both groups and 16 patients had no pain at all, 8 in either group.

Range of motion (Table III). Mean range of motion was mainly unchanged by treatment both by physical therapy and surgery. At test A, 7 patients in the treatment group had an extension lag between 10–20°. At test B, after training, and at test C, after surgery, no changes were found and these patients still had their knee extension lag. In the control group, 7 patients had an extension lag, all less than 10°, and all remained at test B. At test C another 2 patients had an extension

Table II. *Grading of knee pain at test A (commencement of the study), at test B (before surgery) and at test C (3 months after surgery)*

		Number of patients with:			
	Test	No pain	Mild pain	Moderate pain	Severe pain
Treatment group ($n=19$)	A	0	1	10	8
	B	0	3	14	2
	C	8	10	1	0
Control group ($n=20$)	A	0	2	13	5
	B	0	1	19	0
	C	8	10	2	0

Table III. *Passive range of knee motion (ROM) in degrees*

	Test	ROM Mean ± SD	(Range)
Treatment	A	116 ± 14	(85–130)
group	B	119 ± 12	(95–135)
($n=19$)	C	113 ± 13	(80–135)
Control	A	120 ± 15	(95–140)
group	B	118 ± 15	(80–140)
($n=20$)	C	108 ± 18	(65–135)

Table IV. *Number of patients grading the knee as stable or unstable*

	Test	Stable	Unstable
Treatment	A	12	7
group	B	14	5
($n=19$)	C	17	2
Control	A	11	9
group	B	14	6
($n=20$)	C	19	1

lag and mean values were significantly decreased but there was no significant difference between the groups.

Knee stability (Table IV). On clinical examination, by a physician, all knee joints were regarded as stable in both groups at all three tests. At test A, 7 patients in the treatment group and 9 in the control group experienced knee instability. At tests B and C, there were no differences in improvement between the groups and only 3 patients stated knee instability 3 months after surgery.

Muscle strength (Table V). The mean torque of the isokinetic muscle strength measurements sampled at velocities of both 30° and 90° per second was similar in both groups at test A. In comparison to reference values presented for healthy men and women by Aniansson et al. (2), the patients were weak. After physiotherapy (test B) torque was not significantly changed. Torque was similar in both groups at the tested angle velocities and mainly unchanged between tests A and B. At test C, torque was unchanged in the control group, but in the treatment group the peak torque value and the torque value at 60° of knee flexion was significantly decreased at both angle velocities.

The mean flexion/extension ratio was in the treatment group at test A, 0.62 (SD 0.1), at test B, 0.65 (SD 0.20) and at test C, 0.88 (SD 0.60) and in the control group 0.67 (SD 0.30), 0.73 (SD 0.27) and 0.81 (SD 0.46), respectively.

Table V. *Isokinetic quadriceps muscle strength (Torque) expressed in Nm and measured at angle velocities of 30 and 90 degrees per second. Mean values ± SD*

	Test	Peak	30°	60°
90°/second				
Treatment	A	86 ± 34	46 ± 23	79 ± 34
group	B	91 ± 38**	46 ± 19	88 ± 35**
($n=19$)	C	62 ± 26	35 ± 14	59 ± 26
Control	A	87 ± 32	43 ± 17	79 ± 32
group	B	76 ± 34	38 ± 17	68 ± 35
($n=20$)	C	71 ± 36	44 ± 23	69 ± 37
30°/second				
Treatment	A	103 ± 39	48 ± 18	90 ± 36
group	B	112 ± 48**	50 ± 21	100 ± 41**
($n=19$)	C	73 ± 34	45 ± 19	70 ± 33
Control	A	96 ± 41	47 ± 18	84 ± 37
group	B	92 ± 45	46 ± 25	79 ± 43
($n=20$)	C	87 ± 42	51 ± 24	82 ± 41

** = $p < 0.01$.

Walking capacity (Table VI). At tests A, B and C no statistical differences were noticed between the treatment group and the control group concerning the self-selected and maximal walking speeds, the oxygen cost of level walking, and the pain during walking. However, within the groups differences were found.

The self-selected walking speed and the maximal walking speed increased after physiotherapy at an average of 5.8 m/min ($p=0.0001$) and 3.5 m/min ($p=0.005$), respectively in the treatment group but were unchanged in the control group. Between tests B and C there were no significant changes of the maximal walking speed either in the treatment group or in the control group. The total increase of self-selected walking speed from test A to test C was the same in both groups.

Pain during walking was similar in both groups at commencement of the study. At test B there was no change of pain during walking at self-selected or maximal speed either in the treatment group or in the control group. After surgery pain during walking, irrespective of speed, decreased in all patients but at the most in the control group.

Oxygen cost of level walking was not significantly changed after the executed physiotherapy treatment;

Table VI. *Walking speed (self-selected and maximal) ($m \cdot min^{-1}$), pain at walking (points) and oxygen cost of walking ($ml \cdot kg^{-1} \cdot m^{-1}$). Pain and oxygen cost are assessed at all tests in both groups at a walking speed of 62 or 65 $m \cdot min^{-1}$ = the preoperative self-selected walking speed*

	Test	Speed 1 self-selected	Speed 2 maximal	Pain	Oxygen cost
Treatment group ($n=19$)	A	61.9±6.4***	81.2±9.8**	3.6±2.3	0.185±0.022
	B	67.7±5.9	84.7±9.7	3.5±2.3**	0.182±0.021
	C	68.4±8.0	85.1±10.4	1.4±2.0	0.180±0.018
Control group ($n=20$)	A	64.8±10.7	86.0±12.6	3.2±1.0	0.183±0.026
	B	65.5±9.2	84.4±12.3	3.1±1.1***	0.188±0.022
	C	70.3±8.2	88.3±11.9	1.1±1.3	0.174±0.020

** = $p<0.01$, *** = $p<0.001$.

nor was there any difference found in the control group. After surgery the oxygen cost of level walking was unchanged both in and between the groups.

In comparison to the reference values for healthy subjects presented by Inman et al. (6) the patients walked with a higher oxygen cost even 3 months after surgery. In the treatment group one patient used a cane at tests A and B. In the control group one patient used a cane at test C.

DISCUSSION

Patients with osteoarthrosis of the knee are often given treatment by physiotherapists but to our knowledge reports on the effect of such treatment is lacking in the literature. The treatment modalities can vary, and since it is often combined with anti-inflammatory drugs and/or surgery it is difficult to evaluate the effect of physiotherapy *per se* in non-randomized studies. After surgery, especially in elderly patients with osteoarthrosis of the knee, rapid rehabilitation is preferred. In the present study, the effects of preoperative physiotherapy on thigh muscle strength and on walking capacity after unicompartmental replacement of the knee have been analyzed. Clinical examination has been supplemented with objective assessments of muscle strength with an isokinetic dynamometer and of walking capacity with a special equipment for measuring speed and oxygen cost of level walking. Both these methods are well documented and have been found valid and reliable (5, 11, 18, 21). Recently it has been claimed that isokinetic measurements of torque have a limited value in clinical assessments but can be appropriate to use to measure torque production of selected muscle groups if care is taken with regard to axis alignment, calibration, damp and overshoot (15). These factors were taken into account during the isokinetic tests and in accordance with previous reports we found our patients to be weak in the knee extensor and flexor muscles in the limb scheduled for surgery (14). As reported by others we consider knee pain to be the main reason for thigh muscle weakness (15, 3). Since further reduction of muscle strength was expected in the early postoperative course because of the surgical trauma, the preoperative physiotherapy focused on strengthening exercises of the limb to facilitate the postoperative mobilisation. After randomization, two patient groups were established which were very similar with respect to clinical parameters, thigh muscle strength and walking capacity.

After preoperative physiotherapy, thigh muscle strength was not improved but there was a slight decrease of pain, improved subjective stability of the knee and significant increase of the self-selected and maximal walking speeds. Such improvements were not seen in the control group and accordingly these improvements can be considered as an effect of the physiotherapy treatment.

After surgery, thigh muscle strength was retained in the control group, but interestingly, it was decreased in the treatment group. Remaining pain seems not to be the explanation of the difference in muscle strength since all patients experienced significant pain relief and there was no difference between the groups, and there was a normal balance (18, 19) between knee extensors and flexors at all test occasions. Furthermore, torque tests using different angle velocities did not influence the results. In this study pain was only assessed clinically and during walking test. It would have been

of interest to ask the patients to grade any pain during the isokinetic muscle tests.

To judge the outcome of treatment in our patients, functional tests of the knee such as stair or step climbing might have been more appropriate than isokinetic torque measurements. It has also been questioned if measurements of thigh muscle strength do give meaningful information of the knee function needed for walking (9, 15). Previous studies have demonstrated that the walking capacity is reflected more adequately by measurements of walking speed and energy cost of walking (8, 12). In our patients oxygen cost of walking was neither changed by physiotherapy nor by surgery, but the follow-up period might have been too short to reflect improved oxygen cost of walking. With regard to the influence of pain and the short follow-up, we consider the self-selected walking speed as the parameter which most adequately reflects the walking capacity. Thus, the increased self-selected walking speed observed after physiotherapy is interpreted as an effect of the treatment, whereas the short duration of the effect indicates the need for repeated physiotherapy at intervals.

Based on the results of this study, we conclude that in patients with moderate osteoarthrosis of the knee there is no major benefit from preoperative physiotherapy, with the main object of improving thigh muscle strength, unless sufficient pain relief is achieved. To profit from muscle training we suggest that in patients with osteoarthrosis of the knee, preoperative physiotherapy should aim primarily at pain relief.

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