

Early changes in muscle strength after total knee arthroplasty

A 6-month follow-up of 30 knees

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We studied 30 patients with arthrosis in one knee operated on with a cemented (n 26) or an uncemented total knee arthroplasty (TKA) (n 4). Full weight-bearing from the first postoperative day was allowed in all patients, and they received standard postoperative physiotherapy. 1 week prior to surgery, and after 3 and 6 months, isokinetic and isometric muscle strength in both legs were measured, using a Cybex 6000 dynamometer. Isokinetic tests showed a bilateral, significant, and progressive increase (30–53%) in flexor muscle strength most pronounced in the operated legs. Isokinetic extensor strength increased significantly (14–18%) in the operated legs,

while in the contralateral legs, a limited increase was found. Isometric flexion strength significantly decreased in the operated knees (17%).

Isometric extension strength showed a temporary decrease at 3 months, which returned to the preoperative level. No significant change in isometric strength was observed in the contralateral legs. The knee pain during the muscle strength measurements decreased significantly from the preoperative level, which may indicate that the substantial pain relief within 3 months after a TKA is an important factor for evaluation of muscle strength.

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Cross-sectional studies using extensor muscle strength measurements of the knee have shown that muscle strength in patients suffering from moderate to severe osteoarthritis of the knee is decreased by approximately one third compared to healthy controls (Ek Dahl et al. 1989, Madsen et al. 1995). However, the muscle mass of the lower extremities, measured as lean mass using dual energy X-ray absorptiometry in patients with knee arthrosis waiting for a total knee arthroplasty (TKA), was decreased by only 3% compared to the contralateral legs, and isokinetic flexor and extensor muscle strength were decreased by more than 20% in the same patients (Madsen et al. 1997). Previous studies have shown that elderly people with knee arthrosis benefit from physical therapy, focusing mainly on increasing knee motion and strength of periarticular muscles, and that it may postpone surgery a few years (Semble et al. 1990, Fischer et al. 1993). However, no effects of such preoperative physical therapy in patients undergoing knee arthroplasty have been reported with respect to postoperative outcome (Weideheim et al. 1993, D'Lima et al. 1996). Only a few studies have evaluated prospective changes in muscle strength following TKA (Steiner et al. 1989,

Perhonen et al. 1992, Fauré et al. 1993). We examined the early changes in both isokinetic and isometric strength of the knee extensor and flexor muscles after TKA.

Patients and methods

Patients were recruited from 3 hospitals in Copenhagen. The files of 42 patients scheduled for a TKA due to primary arthrosis were evaluated. Patients with heart, liver, renal, gastrointestinal or endocrinological diseases, malignancy, rheumatoid arthritis, gout, paresis or previous fracture of the lower limbs were excluded. Patients scheduled for bilateral TKA were also excluded. Some of the patients, even though not scheduled for bilateral TKA, had mild to moderate symptoms of arthrosis in their contralateral knee which, however, for this study was considered the healthy knee. 30 patients (age 74 (61–85) years, body mass index (weight/height²) 30 (25–41), 25 women) fulfilled the selection criteria and agreed to participate in the study. All patients were operated on with insertion of either a cemented TKA (AGC knee[®] (n 26) or

Table 1. Median (range) values of parameters used for evaluation of the clinical outcome of TKA (n 30)

	Preop.	3 months postop.	6 months postop.	P-value *
Lequesne Index	13 (10–22)	9 (2–19)	6 (2–19)	< 0.000005
Pain level	25 (13–44)	13 (0–38)	10 (0–38)	< 0.00005
ROM	118° (75°–135°)	95° (30°–120°)	100° (80°–120°)	0.001

* Friedman test

an uncemented TKA (Interax total knee system® (n 4). Regardless of implant type and fixation mode, full weight-bearing was allowed from the first postoperative day. All patients received standard postoperative treatment by a physiotherapist while they were in hospital and, except for self-training, no treatment was given afterwards. The study was approved by the local ethics committee and informed consent was obtained from the patients before inclusion.

The clinical outcome was evaluated by examinations performed 1 week before surgery, and 3 and 6 months postoperatively. The examinations included: passive motion of the knee, using a short lever arm goniometer, and pain level assessment (by the patients) of the affected knees, using 5 different numerical rating scales (rating 0–10, 0: no pain, 10: unbearable pain). The scales evaluated: pain at night, pain at rest, pain in walking, the worst pain experienced during the last 2 weeks, and average pain during the last 2 weeks. The pain scores were added together, giving a possible maximum pain score of 50. The Lequesnes index for knee arthrosis (Lequesne et al. 1987), which consists of 10 questions regarding the presence of pain or disability during daily life activities, were used to evaluate the degree of disability (1–4: mild; 5–7: moderate; 8–10: severe; 11–13: very severe; > 14: extremely severe).

Isokinetic and isometric muscle strength were measured using a Cybex 6000 dynamometer, as previously described (Madsen and Brot 1996). Measurements were performed bilaterally and for both the extensor and flexor muscles. The peak torque value was recorded at angle velocities of, respectively, 30°/s and 120°/s for the isokinetic measurements. The peak torque at 75° of knee flexion was recorded for both isometric extension and flexion of the knee. After muscle strength testing, the worst pain experienced during the tests was evaluated on a 0–10 point numerical rating scale.

Statistics

Results are presented as median and total range. Non-parametric two-way analysis of variance (Friedman test) for repeated measurements, and the nonparamet-

ric test for paired data (Wilcoxon test) were used. P-values below 0.05 were considered significant.

Results

The clinical outcome of the TKA-operations showed a significant and progressive reduction in the degree of disability and pain level, but at the expense of a decrease in motion (Table 1). The preoperative peak torque values of both isokinetic and isometric muscle strength were significantly higher (15–40%) in the healthy legs than in the arthrotic legs (Table 2). Isokinetic tests showed a bilateral, significant, and progressive increase in flexor muscle strength of 30% and 53% at angle velocities of, respectively, 30°/s and 120°/s. This increase was most pronounced in the operated legs, but 6 months postoperatively flexor strength was still higher in the healthy legs at both angle velocities. Isokinetic extensor strength measurements showed significant increases of 18% and 14% in the operated legs at 30°/s, and 120°/s, respectively, while we observed only a limited increase in extensor strength in the healthy legs (Table 2).

Isometric flexion peak torque showed a significant decrease of 17% in the operated knees while in the healthy contralateral legs, the strength remained unchanged. Isometric extension peak torque showed a temporary decrease at 3 months, which had returned to the preoperative level 6 months postoperatively. We observed no significant changes in strength in the healthy legs (Table 2). For both isometric flexor and extensor strength measurements, the strength remained significantly higher in the healthy legs than in the legs with TKA throughout the study period. Knee pain level during the muscle strength measurements showed a significant decrease from the preoperative level (Table 2).

Discussion

Fauré et al. (1993) measured prospective changes in isokinetic extensor strength (at angle velocities of 60

Table 2. Bilateral changes in median (range) muscle strength values following TKA and median (range) values of pain rating during the tests (n 30)

	Peak torque values (Nm)			P-value (Friedman test)
	Preop.	3 months	6 months	
<i>Isokinetic tests</i>				
<i>Flexion (30°/s)</i>				
TKA	30 (7-71)	33 (15-73)	39 (1-71)	0.001
Healthy	37 (11-88)	42 (24-89)	42 (24-98)	0.005
%-Diff ^a	19%	21%	7.1%	
<i>Flexion (120°/s)</i>				
TKA	17 (0-53)	21 (1-33)	26 (1-54)	0.02
Healthy	28 (5-71)	28 (5-69)	31 (7-71)	0.04
%-Diff ^a	39%	25%	16%	
<i>Extension (30°/s)</i>				
TKA	57 (19-138)	55 (3-96)	67 (18-111)	0.007
Healthy	67 (16-156)	78 (0-137)	79 (43-146)	0.05
%-Diff ^a	15%	30%	15%	
<i>Extension (120°/s)</i>				
TKA	37 (0-98)	39 (1-75)	42 (15-77)	0.02
Healthy	52 (14-104)	52 (0-89)	53 (24-96)	0.08
%-Diff ^a	29%	25%	22%	
<i>Isometric tests</i>				
<i>Flexion</i>				
TKA	24 (11-84)	21 (7-41)	20 (4-57)	0.0002
Healthy	32 (9-72)	32 (0-71)	33 (11-73)	0.9
%-Diff ^a	25%	34%	39%	
<i>Extension</i>				
TKA	66 (37-183)	55 (23-155)	65 (34-141)	0.004
Healthy	87 (47-17)	92 (0-168)	92 (35-190)	0.97
%-Diff ^a	24%	40%	29%	
<i>Pain during test</i>				
TKA	5 (0-10)	2 (0-8)	1 (0-7)	0.008
Healthy	0 (0-8)	0 (0-5)	0 (0-5)	0.53

^a The percent difference in muscle strength between healthy and operated legs was calculated: %-Diff = 100 × (Healthy-TKA) / Healthy

For all muscle strength parameters at baseline, 3 and 6 months, the median values in the healthy legs are higher than in the TKA legs ($p < 0.05$, Wilcoxon test).

and 120°/s) in 20 patients undergoing one-stage bilateral cemented TKA. The patients received a unicompartmental or a tricompartmental TKA and were randomized to either paramedian or subvastus approaches. Muscle strength testing was performed before surgery and after 1 week, 1 month and 3 months. At 3 months, no significant difference between the groups was found and, on average, muscle strength did not differ significantly from the preoperative level. In our study, the isokinetic extensor strength also was unchanged 3 months after surgery, but strength had increased at 6 months.

In a prospective randomized study, Perhonen et al. (1992) evaluated the effect of intensive postoperative strength training on isometric muscle strength after TKA in patients with arthrosis. The changes in extensor strength (at 90° of knee flexion) showed an identical pattern as in our study with an initial decrease followed by a slow return to the preoperative level. Only in the group of patients participating in the most intensive postoperative training was a significant in-

crease in strength seen between 6 and 12 months after surgery, thus reaching a level significantly higher than the preoperative extensor strength. The isometric flexor strength (at 90° of knee flexion) decreased as in the our study, and only patients in the most intensive training group reached the preoperative level within the first postoperative year.

Wigren et al. (1983) also measured isometric muscle strength after TKA in patients with arthrosis and rheumatoid arthritis. But unfortunately only a few patients with arthrosis had preoperative measurements and data were presented as changes in strength, with the 3-month follow-up as the baseline value. Thus the data could not be compared to our findings. Apparently, increases in isometric flexor strength after TKA could be expected even after 1 year.

The muscle strength changes in the healthy contralateral legs were not recorded in any of the previously published prospective studies (Wigren et al. 1983, Steiner et al. 1989, Perhonen et

al. 1992, Fauré et al. 1993). We showed with the isokinetic tests a clear tendency towards an increase in strength within 6 months after surgery. This finding was confirmed in a large cross-sectional study by Berman et al. (1991), and is important knowledge that should be taken into consideration when cross-sectional studies are performed.

In our study, substantial and significant pain relief was obtained within 3 months after the TKA-operation. Preoperatively, extensor and flexor strength were considerably more reduced than was leg lean mass in a subgroup of the same patients examined in this study (Madsen et al. 1997). Thus the increase in muscle strength after TKA may mainly be related to diminishing joint pain rather than to an increase in muscle mass.

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