Physiotherapy for anterior knee pain: a randomised controlled trial

D I Clark, N Downing, J Mitchell, L Coulson, E P Syzpryt, M Doherty

Abstract

***Objective*—To determine the efficacy of the individual components of physiotherapy in subjects with anterior knee pain.**

***Methods*—An observer blind, prospective, factorial design randomised controlled trial. 81 young adults with anterior knee pain were randomly allocated to one of four treatment groups: (1) exercise, taping, and education; (2) exercise and education; (3) taping and education; and (4) education alone. Each group received six physiotherapist-led treatments over three months. Follow up took place at three months using the following outcome measures: patient satisfaction (discharge/refer for further treatment); a visual analogue pain score; the WOMAC lower limb function score; the Hospital Anxiety and Depression scale (HAD); and quadriceps strength. At 12 months the WOMAC and HAD were assessed by postal questionnaire.**

***Results*—All groups showed significant improvements in WOMAC, visual analogue, and HAD scores; these improvements did not vary significantly between the four groups or between exercising/non-exercising and taped/non-taped patients at three and 12 months. However, patients who exercised were significantly more likely to be discharged at three months than non-exercising patients (χ^2, p<0.001). Taping was not significantly associated with discharge. Significantly greater improvements in WOMAC, visual analogue, and the anxiety score (but not the depression score) were seen in patients who were discharged than in those who were referred.**

***Conclusions*—The proprioceptive muscle stretching and strengthening aspects of physiotherapy have a beneficial effect at three months sufficient to permit discharge from physiotherapy. These benefits are maintained at one year. Taping does not influence the outcome.**

(*Ann Rheum Dis* 2000;**59**:700–704)

Department of Orthopaedics, City Hospital Nottingham
D I Clark
N Downing

Department of Physiotherapy, City Hospital Nottingham
J Mitchell

Trent Institute for Health Services Research, The Medical School Queen's Medical Centre, Nottingham
L Coulson

Queen's Medical Centre, Nottingham
E P Syzpryt

Academic Rheumatology, Clinical Sciences Building, City Hospital Nottingham
M Doherty

Correspondence to:
Dr David Ian Clark, 60 Holme Road, West Bridgford, Nottingham NG2 5AD, UK
Email: davidclark7@compuserve.com

Accepted for publication

Anterior knee pain or patellofemoral pain syndrome is a commonly recognised symptom complex characterised by pain in the vicinity of the patella in young adults worsened by sitting and climbing stairs.[1 2] Anterior knee pain is a common reason for referral to physiotherapy.[3] Different aspects of non-operative management have been emphasised, such as patient education,[4 5] modification of activity,[2 3 5 6] progressive muscle stretching and strengthening,[2–4 6–8] and patella taping.[3 4 8–10] Two large Medline review articles of anterior knee pain[11 12] conclude that there are few controlled clinical trials to identify which elements of conservative treatment are effective. This trial was designed to test the null hypothesis that there was no difference in the efficacy of the key components—namely, proprioceptive muscle stretching and strengthening exercises, and the use of tape (tape applied to skin to alter patella tracking).

Subjects and methods

Ethical approval was obtained from the local research ethics committee and the patients' general practitioners informed of their inclusion in the study. Between September 1995 and February 1998 we recruited to the trial 81 patients (36 female) aged 16–40 years with a history of anterior knee pain of more than three months. Patients were referred from orthopaedic and rheumatology consultants and from general practitioners. Patients were excluded if they gave a history of true locking, patella dislocation, arthritis, any knee radiograph abnormality, ligament laxity (medial and lateral collateral ligament or anterior draw test), malignancy, infection, or previous knee physiotherapy.

Suitable patients gave written consent and were assessed by one of the first two authors by history, locomotor examination, WOMAC score,[13] and the Hospital Anxiety and Depression scale (HAD).[14] The patient's height, weight, and quadriceps strength were measured.

Isometric quadriceps strength was measured using a modified Tornvall chair taking the highest of three readings. A strain gauge measured quadriceps power from 90 degrees flexion to full extension.[15]

RANDOMISATION

The patients were then randomly allocated by the physiotherapist to one of four groups using an individualised computer generated randomisation programme. The four treatment groups were (1) exercise, taping, and education; (2) taping and education; (3) exercise and education; and (4) education alone. It was not felt ethical to have a group that received no treatment in an intervention study of this kind. Each group had six treatments over three months to control for therapist contact time.

INTERVENTIONS

Education

All four groups received the same advice. This involved receiving the Arthritis Research

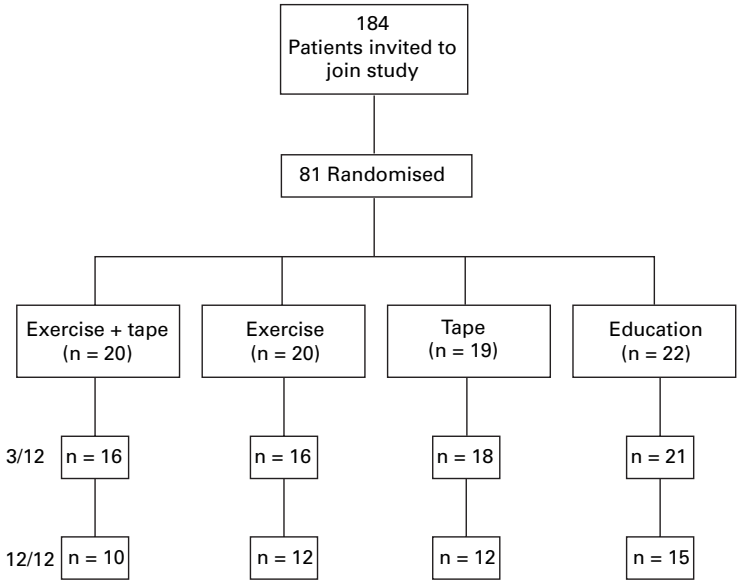

Figure 1 Patient flow.

Campaign leaflet "Knee pain in young adults" and sessions on (*a*) an explanation of the nature of anterior knee pain, the anatomy of the patellofemoral joint, and possible causes of anterior knee pain; (*b*) footwear and appropriate sporting activities; (*c*) pain controlling drugs; (*d*) stress relaxation techniques, ice and massage; (*e*) diet and weight advice; and (*f*) prognosis and self help. On each visit the patient was examined and reassessed. Gait, eccentric muscle control, ability to squat, one leg stance, quadriceps function, iliotibial band gastrocnemius rectus femoris, and hamstring tightness and patella tracking were all assessed.

Table 1 Baseline characteristics. Results are shown as No (%) unless stated otherwise

	1 Exercise + tape (n=20)	*2 Exercise (n=20)*	*3 Tape (n=19)*	*4 Education (n=22)*	*Significance (p value)*
Age (years)					0.31
Mean (SD)	26.0 (7.4)	29.5 (6.2)	29.3 (6.8)	27.1 (7.2)	
Min, max	15, 37	18, 38	17, 40	16, 39	
Sex					0.9
Male	10 (50)	12 (60)	10 (53)	13 (59)	
Female	10 (50)	8 (40)	9 (47)	9 (41)	
Employed					0.70
No	3 (15)	6 (30)	5 (26)	6 (27)	
Yes	17 (85)	14 (70)	14 (74)	16 (73)	
Pain duration					0.56
<3 Months	1 (5)	1 (5)	1 (5)	0	
3–6 Months	0	1 (5)	2 (11)	3 (14)	
6–12 Months	5 (25)	4 (20)	1 (5)	2 (9)	
>12 Months	14 (70)	14 (70)	15 (79)	17 (77)	
Knee pain					
Right	6 (30)	6 (30)	5 (26)	7 (32)	
Left	7 (35)	7 (35)	3 (16)	5 (23)	
Bilateral	7 (35)	7 (35)	11 (58)	10 (45)	
Analgesia					0.44
No	11 (55)	11 (55)	11 (58)	16 (73)	
Yes	9 (45)	9 (45)	8 (42)	5 (23)	
BMI* (mean (SD))	24.8 (5.7)	24.9 (4.2)	25.0 (3.9)	25.2 (4.2)	
BMI grouped					0.84 (BMI <25/BMI >25)
Underweight	4 (20)	1 (5)	2 (11)	2 (9)	
Healthy	7 (35)	11 (55)	10 (53)	9 (41)	
Overweight	8 (40)	5 (25)	5 (26)	8 (36)	
Obese	1 (5)	3 (15)	2 (11)	3 (14)	

*BMI = body mass index.

Stretching and strengthening knee exercises

The exercise group had six sessions of reassessment, education, and knee exercises to improve progressively the motor skill of the lower limb extensors and to stretch tight structures. Patients were taught hamstring, iliotibial band, quadriceps, and gastrocnemius stretches to hold for 10 seconds and repeat 10 times.

All visits began with three minutes' warm up on a static exercise bicycle. Patients were taught to squat on the wall, with hips, knees, and feet in alignment until their hips were at 90 degrees. Patients were instructed to hold this position for 10 seconds and repeat the exercise 10 times. This exercise was lengthened over the six sessions until the patient was able to hold the position for three minutes. Other functional isotonic exercises included sit to stand, proprioceptive balance work using a trampet, and specific exercises for gluteus medius and maximus. Progressive step down exercises were performed. All exercises resulted in strong eccentric contraction of lower limb extensors. Patients were instructed to repeat the exercises every day and a diary sheet was supplied to help compliance.

Taping

The taping group had six sessions of assessment, education, and taping. Tape was applied from the lateral border of the patella pulling medially and upwards over the medial femoral condyle. Taping in this way should reduce pain on the squat test and wall/step down test. If this did not eliminate the pain then the taping was repeated in knee flexion. Tape was given to the patient and applied each day over attendances 1–3 inclusive during all activities. During the fourth and fifth visits taping was only applied during painful activities. On the sixth session the tape was removed. The exercise and taping group included all of the above.

OUTCOME MEASUREMENTS

A blinded independent observer undertook assessment on the sixth visit. The primary outcome measure was an assessment of patient satisfaction (satisfied = discharge, not satisfied = continue physiotherapy, or refer to consultant). Secondary outcome measures were a visual analogue pain score (two 0–100 mm horizontal scales which indicated difficulty in climbing stairs and walking on the flat, with "no pain" and "extreme pain" at each end; total score 200) and the WOMAC lower limb function score (Likert version). In addition, patients filled out the HAD score, and had the strength of their quadriceps measured.

At a minimum of one year patients were then sent a further postal questionnaire, visual analogue pain score, the WOMAC score, and the HAD score. The physiotherapy and medical outpatient attendances were traced for Nottingham in those patients who failed to respond to two questionnaires and a phone call.

BLINDING

The assessors before and after the intervention were unaware of the intervention given. The patients themselves were not completely

Table 2 Primary outcome measure at three months after baseline. Results are shown as No (%)

	1 Exercise + tape (n=20)	2 Exercise (n=20)	3 Tape (n=19)	4 Education (n=22)	All patients (n=81)
Discharged	19 (95)	20 (100)	8 (42)	13 (59)	60 (74)
Referred	1 (5)	0	11 (58)	9 (41)	21 (26)

blinded because they were aware that of the four types of treatment one group would receive advice only.

STATISTICAL ANALYSIS

The study was based on a 2×2 factorial design. With a 90% power of detecting a 40% difference in discharge rates between muscle strengthening and taping at a significance level of 5% a minimum of 14 patients would be required in each arm of the study—that is, a minimum of $14 \times 4 = 56$ patients. Patients who failed to attend were included in the analysis on an intention to treat basis.

Data were analysed using SPSS, version 8.0. All the baseline significance tests were χ^2 (categorical variables) except for age (one way analysis of variance (ANOVA) for continuous variables). We found no evidence of an interaction between exercise and taping and so our analysis focused on comparing all four groups and comparing taped with non-taped patients and exercising with non-exercising patients. χ^2 Tests were used for categorical outcomes and Student's *t* tests, Mann-Whitney U test, and Kruskall-Wallis test for continuous outcomes.

Results

PATIENT FLOW

Of the 184 patients invited to join the study, 81 were recruited (40 patients did not attend, 36 patients had a different diagnosis, seven were already better, six refused consent, one had previous physiotherapy, three were too young/old, two had had recent surgery, and eight had miscellaneous reasons) (fig 1). 10 patients withdrew during the study and these were included in the analysis on an intention to treat basis. 49 patients returned the questionnaires at 12 months.

BASELINE CHARACTERISTICS OF THE PATIENTS

There were no significant differences between the four groups in age, sex, employment status (students were included in the employed group), duration of knee pain, use of analgesia (simple or anti-inflammatory types and regular or intermittent use were also similar between the groups), or body mass index (table 1). There were also no differences in baseline WOMAC score, visual analogue score, HAD scores, or quadriceps power (see table 3).

PRIMARY OUTCOME MEASURE: PATIENT SATISFACTION (TABLE 2)

Patients who had the proprioceptive stretching and strengthening exercise component of the physiotherapy were significantly more likely to be discharged than non-proprioceptive exercising patients (χ^2, $p<0.001$). Taping alone was not significantly associated with discharge.

Table 3 WOMAC, visual analogue (VA), Hospital Anxiety and Depression (HAD) scores, and quadriceps strength at baseline, three months, and 12 months (WOMAC out of 96, VA out of 200, HAD anxiety out of 21, HAD depression out of 21, quadriceps strength (kgF). Results are shown as No (%) unless stated otherwise

	1 Exercise + tape (n=20)	2 Exercise (n=20)	3 Tape (n=19)	4 Education (n=22)	Significance (p value)
Baseline					
WOMAC (mean (SD))	25.2 (12.5)	23.7 (12.9)	33.4 (16.8)	28.7 (15.4)	0.23
VA score (mean (SD))	75.6 (32.6)	77.1 (44.4)	83.9 (39.8)	76.99 (41.8)	0.94
HAD anx					0.43
Mean (SD)	5.6 (2.9)	6.5 (3.9)	6.7 (4.2)	6.8 (2.3)	
Normal	16 (80)	14 (70)	13 (68)	16 (73)	
Borderline	3 (15)	3 (15)	4 (21)	4 (18)	
Anxious	1 (5)	3 (15)	2 (11)	2 (9)	
HAD dep					0.16
Mean (SD)	3.2 (2.8)	3.1 (2.4)	4.0 (4.3)	4.6 (2.9)	
Min, max	0, 9	0, 8	0, 14	1, 13	
Normal	17 (85)	17 (85)	16 (84)	19 (86)	
Borderline	3 (15)	3 (15)	1 (5)	2 (9)	
Depressed	0	0	2 (11)	1 (5)	
R quads (mean (SD))	186.8 (133.0)	233.2 (148.5)	198.7 (144.7)	190.6 (107.8)	0.52
L quads (mean (SD))	169.4 (100.0)	224.7 (130.9)	156.7 (106.1)	205.6 (130.8)	0.52
Three months					
WOMAC (mean (SD))	11.5 (10.5)	10.0 (11.8)	20.9 (15.5)	13.8 (15.8)	0.11
VA score (mean (SD))	35.9 (28.7)	30.0 (39.9)	57.8 (38.7)	41.8 (40.6)	0.17
HAD anx (mean (SD))	3.3 (2.5)	5.1 (4.7)	5.7 (4.3)	5.5 (3.4)	0.25
HAD dep (mean (SD))	1.8 (1.5)	2.2 (2.4)	2.8 (3.4)	3.0 (2.7))	0.46
R quads (mean (SD))	280.4 (149.9)	320.1 (193.6)	222.5 (143.1)	258.8 (159.6)	0.39
L quads (mean (SD))	266.9 (132.9)	307.9 (162.4)	189.4 (122.4)	279.9 (155.1)	0.12
Twelve months					
WOMAC (mean (SD))	14.8 (18.0)	15.6 (16.2)	27.6 (22.7)	22.0 (21.3)	0.38
VA score (mean (SD))	35.1 (45.1)	37.8 (43.4)	77.3 (62.8)	51.9 (53.8)	0.22
HAD anx (mean (SD)	4.6 (3.2)	5.3 (5.2)	5.2 (2.8)	5.2 (3.3)	0.97
HAD dep (mean (SD))	2.0 (1.3)	3.0 (3.3)	3.9 (4.0)	3.7 (3.6)	0.54

Table 4 Mean difference between exercising/non-exercising patients and taped/non-taped patients

	Exercising	*Non-exercising*	*Taped*	*Non-taped*
Change in WOMAC (SD)	−11.7 (12.4)	−13.4 (14.2)	−11.8 (15.3)	−13.3 (11.5)
p Value*	0.6		0.65	
Mean difference (95% CI)	1.7 (−4.7 to 8.1)		1.4 (−5.0 to 7.9)	
Change in VA† (SD)	−34.4 (41.6)	−26.8 (43.8)	−27.9 (47.5)	−32.2 (38.3)
p Value*	0.46		0.67	
Mean difference (95% CI)	−7.6 (−28 to 12.9)		4.5 (−16.0 to 25.0)	
Change in HAD† anx (SD)	−1.6 (2.3)	−0.87 (3.2)	−1.2 (3.2)	−1.3 (2.5)
p Value*	0.29		0.82	
Mean difference (95% CI)	−0.7 (−2.17 to 0.6)		0.2 (−1.2 to 1.5)	
Change in HAD dep (SD)	−0.97 (1.9)	−1.1 (1.7)	−0.9 (3.2)	−1.2 (1.3)
p Value*	0.76		0.56	
Mean difference (95% CI)	0.1 (−0.7 to 1.0)		0.3 (−0.6 to 1.1)	
Change in quadriceps strength (SD)	91.2 (95.4)	55.7 (113)	62.6 (108)	80.8 (104.9)
p Value*	0.18		0.50	

*Student's *t* test.
†VA = visual analogue; HAD = Hospital Anxiety and Depression Scale.

SECONDARY OUTCOME MEASURES (TABLE 3)

WOMAC and visual analogue scores

At three months the WOMAC and visual analogue scores improved significantly in all patients (Wilcoxon matched pairs signed ranks test, p<0.0001), but these improvements did not vary significantly between the four groups or between exercising and non-exercising patients or taped and non-taped patients (table 4). Scores improved significantly more among patients who were discharged than among patients who were referred (WOMAC p=0.03; visual analogue p=0.02).

At one year all groups had improved significantly (Wilcoxon matched pairs signed ranks test: WOMAC p=0.005; visual analogue p=0.007). One way ANOVA tests failed to show significant differences in score or changes in score between the four groups (table 3). However, patients who performed exercises had significantly lower pain scores than those who did not (Mann-Whitney U, p=0.03). Taping had no detectable effect on score.

WOMAC scores improved significantly more among patients who were no longer troubled by knee pain than among those who were not troubled (independent samples *t* test: WOMAC p=0.02; visual analogue p=0.001).

Anxiety and depression score (table 3)

At three months the HAD anxiety and depression scores improved significantly in all patients (anxiety p=0.0005, depression p=0.0001), but these improvements did not vary significantly between the four groups (table 3) or between exercising and non-exercising patients or taped and non-taped patients (table 4). Anxiety scores improved significantly more in patients who were discharged than in patients who were referred (anxiety p=0.05), but depression scores did not (p=0.56).

At 12 months the HAD anxiety (p=0.02) but not the HAD depression score (p=0.07) had improved significantly in all patients. However, one way ANOVA tests showed no significant differences between the four groups in change in HAD scores.

Quadriceps strength (table 3)

Quadriceps power in the affected leg(s) improved significantly in all patients (p<0.001) but by more in the exercising and education groups than in the group with tape alone (table 3). This result approached significance (p=0.08).

ONE YEAR QUESTIONNAIRE (TABLE 5)

The number receiving further physiotherapy and the number still troubled by their knee pain were not significantly different between the four groups. However, patients who exercised were less likely to have severe knee pain than those patients who did not exercise (χ^2, p=0.08).

Table 5 One year questionnaire. Results are shown as No (%)

(a) Question "Have you had a further course of physiotherapy for your knee pain?"

More physiotherapy	*Exercise + tape (n=20)*	*Exercise (n=20)*	*Tape (n=19)*	*Education (n=22)*	*Significance* (p value)*
Yes	2 (10)	2 (10)	3 (16)	5 (23)	
No	17 (85)	18 (90)	16 (84)	17 (77)	0.63

(b) Question "Are you still troubled by your knee pain?"

Still troubled	*Exercise + tape (n=10)*	*Exercise (n=12)*	*Tape (n=12)*	*Education (n=15)*	*Significance* (p value)*
Yes	6 (60)	7 (58)	9 (75)	13 (87)	
No	4 (40)	5 (42)	3 (25)	2 (13)	0.33

*One way ANOVA.

Discussion

The patients who had proprioceptive muscle stretching and strengthening exercises were significantly more likely to be satisfied and discharged at three months than those patients who had taping and education alone (p=0.001). At one year patients who performed exercises had significantly better pain scores than those who did not and were less likely to be troubled by their knee pain. However, the results showed an equal improvement in visual analogue pain score and WOMAC lower limb functional score for all four treatment groups at three and 12 months. No difference could be shown in these outcome measures between the groups. This may indicate that the WOMAC score is not sufficiently sensitive in this group of patients. This is the first time that the WOMAC score, designed for assessment of hip or knee osteoarthritis, has been used to assess anterior knee pain without structural change. This group of young adults did not have high levels of baseline pain or disability and were not significantly anxious or depressed. Nevertheless, we

did show a significant reduction in the WOMAC scores in all the groups.

No additional benefit of the use of tape to correct patella glide, above that of patient education and therapist contact, sufficient to allow discharge has been shown. For the purposes of this trial taping was used in a standardised way to improve patella glide only. In a clinical setting taping can be applied to correct patella tilt, patella rotation, or for fat pad unloading. This trial does not consider these uses of taping. Taping can be used in isolation[11 12] but is usually applied to reduce pain to enable proprioceptive exercises to take place, as in the McConnell regimen.[4] In our patients we did see short term benefit, allowing exercises to take place. However, we did not show any benefit from this use of tape in WOMAC or visual analogue scores above that of therapist contact and education sufficient to allow discharge. Indeed our results suggested that quadriceps strengthening in the tape alone group was less than in all the other patients, possibly owing to muscle inhibition or persistent pain.

The results have identified the importance of therapist contact and the value of education and simple advice: pain, function, wellbeing, and quadriceps strength improved sufficiently in 60% of patients with this intervention alone for them to require no further treatment. This is the first study to control for the effect of therapist contact.

The McConnell-type physiotherapy programme is widely used for treating anterior knee pain.[3] Our findings agree with uncontrolled trials claiming overall benefits of the McConnell-type physiotherapy programme for anterior knee pain.[4 9] What has not been considered before is which specific components of physiotherapy are effective—that is, taping, exercises, or the patient education and therapist contact. Our results do not support other small uncontrolled trials that taping is of additional value in reducing pain.[16 17] Our results agree with a small comparative trial of 20 subjects which suggested that taping has no benefit over standard physiotherapy alone.[18] It is interesting to note that in knee osteoarthritis similar findings of the benefit of therapist contact and education have been shown.[19] The benefit of physical exercise above this has also been shown previously.[20] It therefore seems that such treatment is helpful for knee pain, whether or not there is any structural change.

There are several important caveats to our study. This is a single centre study with relatively small numbers. The physical interventions could not be blinded for the patient and a significant number of patients left the study over the 12 months. The WOMAC score was administered by different blinded investigators at baseline and three months, and by post at one year, possibly introducing an element of bias. Despite these limitations we have shown the value of patient education and therapist contact alone. The addition of proprioceptive muscle strengthening and stretching exercises improves the response significantly above this, sufficient for patients to be discharged.

We therefore recommend that patients in the community with anterior knee pain should be considered for a course of physiotherapy which focuses on patient education and activity modification, with the addition of proprioceptive exercises and stretches.

It is suggested that future studies might look at the value of simple advice sheets and patient education compared with physiotherapy and look at the longer term follow up of these patients.

1 Heng RC, Haw CS. Patello-femoral pain syndrome. Current Orthopaedics 1996;10:256–66.
2 Tria AJ, Palumbo RC, Alicia JA. Conservative care for patellofemoral pain. Orthop Clin North Am 1992;23:545–54.
3 Hilyard A. Recent advances in the management of patellofemoral pain: the McConnell programme. Physiotherapy 1990;76:559–65.
4 McConnell J. The management of chondromalacia patellae: a long-term solution. The Australian Journal of Physiotherapy 1986;32:215–23.
5 Reid DC. The myth, mystic and frustration of anterior knee pain [editorial]. Clin J Sports Med 1993;3:139–43.
6 Kujala UM. Patellofemoral problems in sports medicine. Ann Chir Gynaecol 1991;80:219–23.
7 Garrick JG. Anterior knee pain (chondromalacia patella). Physician and Sportsmedicine 1989;17:75–84.
8 Fulkerson JP, Shea KP. Current concepts review: disorders of patellofemoral alignment. J Bone Joint Surg Am 1990;72:1424–9.
9 Gerrard B. The patello-femoral pain syndrome: a clinical trial of the McConnell programme. The Australian Journal of Physiotherapy 1989;35:71–80.
10 Gilleard W, McConnell J, Parsons D. The effect of patella taping on the onset of vastus medialis obliquus and vastus lateralis muscle activity in persons with patellofemoral pain. Phys Ther 1998;78:25–32.
11 Cutbill JW, Ladly KO, Bray RC, Thorne P, Verhoef M. Anterior knee pain: a review. Clin J Sports Med 1997;7:40–5.
12 Arroll B, Ellis-Pegier E, Edwards A, Sutcliffe G. Patello-femoral pain syndrome. A critical review of the clinical trials on non operative therapy. Am J Sports Med 1997;25:207–12.
13 Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt L. Validation study of WOMAC: a health status instrument for measuring clinically-important patient-relevant outcomes following total hip or knee arthroplasty in osteoarthritis. J Rheumatol 1988;15:1833–40.
14 Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand 1983;67:361–70.
15 Tornville G. Assessment of physical capabilities with special reference to the evaluation of maximum voluntary isometric muscle strength. Acta Physiol Scand 1963;58(suppl 201):1–102.
16 Bockrath K, Wooden C, Worrall T, Ingersall CD, Farr J. Effects of patella taping on patella position and perceived pain. Med Sci Sports Exerc 1993;25:989–92.
17 Herrington L, Payton CJ. Effects of corrective taping of the patella on patients with patellofemoral pain. Physiotherapy 1997;83:566–74.
18 Kowall MG, Kolk G, Nuber GW, Cassisi JE, Stern SH. Patella taping in the treatment of patellofemoral pain. A prospective randomised study. Am J Sports Med 1996;24:61–6.
19 Mazzuca SA, Brandt KD, Katz BP, Chambers M, Byrd D, Hanna M. Effects of self-care education on the health status of inner city patients with osteoarthritis of the knee. Arthritis Rheum 1997;40:1466–74.
20 O'Reilly SC, Muir KR, Doherty M. Effectiveness of home exercise on pain and disability from osteoarthritis of the knee: a randomised controlled trial. Ann Rheum Dis 1999;58:15–19.