The effects of a non-operative multimodal programme on osteoarthritis of the knee

Shelain Patel¹, Fahad S Hossain¹, Bruce Paton², Fares S Haddad¹

Departments of ¹Trauma and Orthopaedics and ²Physiotherapy, University College Hospital, London, UK

ABSTRACT

INTRODUCTION The purpose of this study was to determine if a multimodal programme including physiotherapy and education could improve the symptoms of osteoarthritis of the knee across various severities of disease.

PATIENTS AND METHODS Seventy-two patients with osteoarthritis of the knee confirmed on radiographic evidence were referred over a 13-month period for a lower limb programme which consisted of 12 classes over 6 weeks of group physiotherapy and included education on osteoarthritis, diet and exercise. Six patients went on to have joint arthroplasty at a mean time of 6.5 months with three placed on the waiting list during follow-up.

RESULTS Pre-intervention, the mean WOMAC score was 42.0 and the mean Oxford Knee Score was 32.8. Post-intervention at a mean follow-up of 12 months, the mean WOMAC score was 31.6 and the mean Oxford Knee Score 24.3. The change in scores following intervention was statistically significant ($P < 0.01$). Using the WOMAC scoring system, the greatest effect size was seen in patients with Kellgren–Lawrence grade IV whilst using the Oxford knee scoring system, the greatest effect size was seen in patients with Kellgren–Lawrence grade II.

CONCLUSIONS At 12 months, a multimodal programme of non-operative interventions has an excellent impact upon the symptoms of osteoarthritis of the knee with improved patient-reported scores. The level of improvement cannot be inferred from the radiographic grade of osteoarthritis. This modality could be considered for all patients with mild-to-moderate osteoarthritis of the knee.

KEYWORDS

Osteoarthritis – Knee – Physiotherapy – Education – Classes

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CORRESPONDENCE TO

Shelain Patel, Orthopaedic Clinical Research Fellow, Department of Trauma and Orthopaedics, University College Hospital, 235 Euston Road, London NW1 2BU, UK. E: shelain.patel@doctors.org.uk

Osteoarthritis of the knee is a leading cause of chronic disability affecting 10% of the population over the age of 55 years and is expected to rise as the population gets older. Whilst operative arthroplasty treatment is an important treatment option, it is not yet a fail-safe option and 15-year survivorship is only 81–92%.¹ Overall satisfaction, however, is lower, particularly in younger patients;² it is 82% at one year² and this can drop to 75% in the longer-term.⁵ For this reason and also because of patient factors and choice, the convention is generally to advocate non-operative measures for early disease and operative interventions when these fail. Not all cases of osteoarthritis of the knee will progress;⁴ thus, non-operative treatment will be sufficient for a large number of patients.

There are guidelines that give a consensus on non-operative treatment⁵ but no gold standard; it may be that patients respond in differing magnitude to different treatment modalities due to variability in aetiology, location of

disease and contributing factors. Of the non-operative options, analgesia and specifically use of non-steroidal anti-inflammatory drugs (NSAIDs) is more prevalent in the primary care setting than physiotherapy⁶ in managing osteoarthritis of the knee though concerns remain with regards to their safety, efficacy and cost.^{7–10} In contrast, patient education influences outcomes in a number of diseases,¹¹ whilst the positive influence of diet and exercise on osteoarthritis is well documented.^{12–14}

Recent work by Hurley and colleagues^{15,16} has demonstrated both a cost and functional benefit with knee arthritis group classes combining education with circuit exercise regimens. Our institution undertakes a similar approach; however, classes are less specialised for osteoarthritis of the knee and contain patients with other lower limb musculoskeletal conditions including arthritis of the hip, foot, ankle as well as other knee pathologies such as meniscal injuries and chondromalacia patella. The purpose of our

study is to report the results of a generalised, multimodal, non-operative programme specifically looking at outcomes in patients with osteoarthritis of the knee.

Patients and Methods

Patients

A total of 72 patients (mean age $\pm$ SD, 64.2 ± 9.1 years; 24 males, 48 females) with osteoarthritis of the knee were enrolled. The patients were selected from the Beginner Lower Limb Classes at University College Hospital. Entry criteria included symptomatic lower limb joint pathology. Exclusion criteria for the classes included patients who were immediately deemed candidates for surgical interventions or unlikely to be able to participate in the classes due to pre-existing cardiovascular, cognitive or neurological problems.

All study patients had radiographic evidence of osteoarthritis and were staged according to the Kellgren–Lawrence scale. Radiographs were standardised and included anteroposterior weight-bearing, lateral and skyline views of both knees. Sixty patients were affected by medial compartment disease, eight by lateral compartment disease and 24 by patellofemoral compartment disease; the mean number of diseased compartment was 1.5.

Programme

Patients were enrolled into a 6-week programme of 12 semi-weekly 1-h classes between April 2007 and May 2008 with 12 patients per class. An attendance record was made for each patient. Each class commenced with physiotherapist-led education discussing aspects of patient safety, disease pathology and progression, the effect of exercise on joints, footwear and orthotics, and how to minimise complications such as

swelling and pain following each class. Advice on weight management was given by a lecture, delivered by a dietician in the second week of the programme.

An exercise programme was completed by each patient in each class targeting joint flexibility, muscle strength, cardiovascular training, balance and proprioception. This involved stretching and warm-up exercises for 15 min followed by a 10-circuit station (Table 1). Each station lasted 1 min initially with 2 min recovery time between stations and was progressively increased to 3 min per station with 1 min recovery in the final week of the programme. Written information was given at the end of the final class on local council run exercise programmes to enable patients to self-manage their own exercise and activity.

Study design and outcomes

A prospective observational study was conducted at our institution and all the patients provided informed consent. All patients were asked to complete questionnaires to evaluate their Oxford Knee Score and WOMAC pain, stiffness and physical function subscales to obtain baseline values. With respect to the WOMAC subscales, these values were added to give a cumulative WOMAC score. Patients were longitudinally followed-up to determine whether there was a change in these scores and whether any had undergone surgical intervention.

Statistical analysis

Baseline outcome scores pre-intervention were used as controls. Outcome scores at follow-up were used as the treated group. Statistical difference between the functional outcomes for the control and treated groups was evaluated using a dependent *t*-test for paired samples. The effect size

Table 1 Exercise circuit undertaken

Station	Exercise	Facet trained	Regimen
1	Leg press	Strength	Aiming for 3 sets of 10 RM weight and weekly progression of weight with double leg press progressing to single leg press
2	Bike	Aerobic	Increasing distance and resistance
3	Hip extension	Strength/flexibility	Increasing motion
4	Sit-to-stand with medicine ball	Aerobic	Increasing frequency
5	Hamstring curl	Strength	Increasing weights
6	Step-down	Aerobic	Increasing frequency
7	Calf raise	Strength	Double leg progressing to single leg
8	Single leg balance on mini-trampoline	Balance	Eyes open progressing to eyes closed
9	Single leg balance on wobble cushion	Balance	Eyes open progressing to eyes closed
10	Step-up	Aerobic/flexibility	Increasing height of steps

Table 2 Effect sizes and changes in WOMAC and Oxford Knee Score for each Kellgren–Lawrence grade

Kellgren–Lawrence grade	Patients (n)	WOMAC		P-value	Effect size (r)	Oxford Knee Score		P-value	Effect size (r)
		Pre	Post			Pre	Post		
II	17	26.9	20.6	0.04	0.23	29.1	19.1	< 0.001	0.51
III	37	43.1	32.8	< 0.001	0.28	32.2	23.6	< 0.001	0.40
IV	18	54.1	39.7	0.004	0.42	37.3	30.8	0.002	0.27

for each grade of osteoarthritis was determined to see which patients were most affected by the intervention, if any. A Spearman rank correlation coefficient was used to evaluate the strength of association between the number of classes attended and change in functional outcome measures to see if this was an important variable. All statistical analyses were done with use of XLSTAT-PRO 11 for Microsoft Excel. A statistical value of $P < 0.05$ was considered to be significant.

Results

A total of 72 patients were included in the study with six undergoing knee arthroplasty (mean time between classes and surgery, 6.5 months) and three patients awaiting knee arthroplasty surgery during follow-up. For those patients who had undergone surgery, the post-intervention scores were recorded before surgery since this second intervention was very likely to impact upon their function. The overall mean follow-up time was 12 months (range, 4–24 months).

There was a significant improvement in both WOMAC and Oxford Knee Score following the classes at follow-up. The mean WOMAC score improved from 42.0 (range, 1–90) to 31.6 (range, 1–83; $P < 0.01$) and the mean Oxford Knee Score improved from 32.8 (range, 13–54) to 24.3 (range, 12–52; $P < 0.01$). Mean pain, stiffness and function subscales of the WOMAC score improved from 10.3 to 8.7; 3.5 to 2.6; and 28.3 to 20.3, respectively.

Using the WOMAC scoring system, the greatest effect size was seen in patients with Kellgren–Lawrence grade IV and the least in grade II. Using the Oxford knee scoring system, the greatest effect size was seen in patients with Kellgren–Lawrence grade II and the least in grade IV (Table 2).

Subgroup analysis of those patients who had undergone or were awaiting arthroplasty demonstrated that the multimodal classes led towards a non-significant deterioration in both WOMAC and Oxford Knee Score. The mean WOMAC score changed from 46.1 to 49.2 ($P = 0.32$) and the mean Oxford Knee Score changed from 39.7 to 40.7 ($P = 0.34$).

Figure 1 No correlation observed between the number of classes and percentage change in WOMAC score ($R = 0.017$).

Figure 2 No correlation observed between the number of classes and percentage change in Oxford Knee Score ($R = -0.018$).

Using a Spearman rank correlation coefficient, no correlation was demonstrated between the number of classes attended and percentage change in outcome measure (Figs 1 and 2).

Discussion

This study demonstrates that, at 12 months, a multimodal programme consisting of non-operative interventions has

an excellent impact upon the symptoms of osteoarthritis of the knee. There is a statistically significant improvement in patient-reported outcome scores. Our results do not conclusively prove which grade of osteoarthritis improves the most following the programme. Whilst patients were enrolled when operative treatment was not felt to be a suitable initial option, it must be remembered that six of our original group of patients (8.3%) went on to have joint arthroplasty during the follow-up period. This suggests that it should not be regarded as a fail-safe option for all patients since a number are likely to need operative treatment at some stage due to either the natural progression of disease or on-going symptoms. Indeed, in our cohort, those patients who went on to have or were offered joint arthroplasty showed no improvement in outcome score during follow-up.

The success of the programme is likely to be multifactorial. With respect to exercise, recent National Institute for Health and Clinical Excellence (NICE) guidelines¹⁷ suggested that exercise comprising of local muscle strengthening, and general aerobic fitness should be a core component of treatment, irrespective of age, co-morbidity, pain severity or disability. It is known that patients with osteoarthritis of the knee have strength deficits in muscle groups around the knee, especially in the quadriceps muscle, though it is unknown if the symptoms are related to disuse¹⁸ or precede the disease with weakness as a risk factor itself.¹⁹ A key component of our programme is the exercise circuit which builds up muscle bulk and aerobic stamina. Overall, such physiotherapy methods have been shown to be beneficial at up to 3 years²⁰ but some consider this to be a placebo effect.^{21,22}

There is a belief amongst patients that osteoarthritis is part of the normal ageing process with few treatment options available;^{23–25} thus, education forms a crucial part of our programme. We focused on three areas: (i) the influence of diet and obesity; (ii) the osteoarthritic disease process; and (iii) self-management with pacing and active coping strategies taught.

There is increasing literature regarding the long-term influence of a patient's bodyweight on osteoarthritis. Increasing body fat is associated with the development of osteoarthritis in normal knees,²⁶ whilst obesity is more prevalent in patients with osteoarthritis of the knee.^{27,28} Although a reduction in bodyweight reduces compressive forces through the knee joint,¹⁵ it is unclear if obesity actually alters disease progression. Niu *et al.*²⁹ demonstrated that it does not change in the more common varus deformity though does for neutral or valgus deformities, whilst Felson *et al.*³⁰ suggested that obesity is a risk factor in knees with 3–6° of malalignment irrespective of varus or valgus deformity. Nonetheless, a combination of exercise and weight loss has been shown to improve function¹⁴ and, consequently, was integrated into our programme.

Information is given to our patients informing them of local community-based exercise programmes since it is our belief that self-management plays a large role in the sustained changes seen. Adherence to exercise especially in overweight patients is known to improve physical function¹² and perceptions of disease control.³¹

Since most patients did not attend all 12 classes, it was hypothesised that the number of classes attended would correlate with a proportional improvement in function; however, this was not our experience. This is likely to be due to a number of reasons. Although there is no way to measure group dynamics, it was the authors' experience that those classes where patients worked effectively together improved the most. Furthermore, it is known that a complex interplay exists in knee osteoarthritis between depression, pain, disease knowledge, and physical ability.³² Our classes address issues regarding pain, knowledge and seek to improve physical ability but do not have the scope to identify or treat depression. If this aspect of the patient is ignored, it is likely that this will limit the improvements that are achieved.³³

Hassett *et al.*⁴ demonstrated a link between the progression of knee osteoarthritis and progression of lumbar spine and hip osteoarthritis. Whilst it is not known whether the arrest of disease progression in the knee will arrest osteoarthritis in other joints, we undertook a more generalised approach to the entire lower limb so that multiple joints are treated.

Study limitations

Although this is a prospective study, it is limited through its composition of a single treatment group and does not provide comparison to a control group of either no treatment or sham physiotherapy or education. Furthermore, we determined the grade of osteoarthritic change based upon standard radiographs of the knees though this is known to correlate only moderately with the actual degree of articular cartilage degeneration.³⁴

Further work is needed to evaluate the long-term impact of these classes beyond 1 year, and to assess whether the classes are also effective in improving outcomes in other osteoarthritic joints and in those patients who go on to receive joint arthroplasty surgery.

Conclusions

Osteoarthritis of the knee is a major health problem associated with long-term physical disability. We have shown that, in cases amenable to non-operative treatment, a series of classes encompassing education and exercise is of benefit in improving the outcome of mild-to-moderate osteoarthritis of the knee at one year.

References

1. Roberts VI, Esler CN, Harper WM. A 15-year follow-up study of 4606 primary total knee replacements. *J Bone Joint Surg Br* 2007; **89**: 1452–6.
2. Baker PN, van der Meulen JH, Lewsey J, Gregg PJ; National Joint Registry for England and Wales. The role of pain and function in determining patient satisfaction after total knee replacement. Data from the National Joint Registry for England and Wales. *J Bone Joint Surg Br* 2007; **89**: 893–900.
3. Noble PC, Conditt MA, Cook KF, Mathis KB. The John Insall Award: Patient expectations affect satisfaction with total knee arthroplasty. *Clin Orthop* 2006; **(452)**: 35–43.
4. Hassett G, Hart DJ, Doyle DV, March L, Spector TD. The relation between progressive osteoarthritis of the knee and long term progression of osteoarthritis of the hand, hip, and lumbar spine. *Ann Rheum Dis* 2006; **65**: 623–8.
5. Zhang W, Moskowitz RW, Nuki G, Abramson S, Altman RD, Arden N *et al*. OARSI recommendations for the management of hip and knee osteoarthritis, Part II: OARSI evidence-based, expert consensus guidelines. *Osteoarthritis Cartilage* 2008; **16**: 137–62.
6. Jordan KM, Sawyer S, Coakley P, Smith HE, Cooper C, Arden NK. The use of conventional and complementary treatments for knee osteoarthritis in the community. *Rheumatology* 2004; **43**: 381–4.
7. Hippisley-Cox J, Coupland C. Risk of myocardial infarction in patients taking cyclo-oxygenase-2 inhibitors or conventional non-steroidal anti-inflammatory drugs: population based nested case-control analysis. *BMJ* 2005; **330**: 1366–9.
8. Hippisley-Cox J, Coupland C, Logan R. Risk of adverse gastrointestinal outcomes in patients taking cyclo-oxygenase-2 inhibitors or conventional non-steroidal anti-inflammatory drugs: population based nested case-control analysis. *BMJ* 2005; **331**: 1310–6.
9. Bjordal JM, Ljunggren AE, Klovning A, Stordal L. Nonsteroidal anti-inflammatory drugs, including cyclo-oxygenase-2 inhibitors, in osteoarthritic knee pain: meta-analysis of randomised placebo controlled trials. *BMJ* 2004; **329**: 3117–22.
10. Solomon DH, Glynn RJ, Bohn R, Levin R, Avorn J. The hidden cost of nonselective nonsteroidal antiinflammatory drugs in older patients. *J Rheumatol* 2003; **30**: 792–8.
11. Chodosh J, Morton SC, Mojica W, Maglione M, Suttrop MJ, Hilton L *et al*. Meta-analysis: chronic disease self-management programs for older adults. *Ann Intern Med* 2005; **143**: 427–38.
12. van Gool CH, Penninx BW, Kempen GI, Rejeski WJ, Miller GD, van Eijk JT *et al*. Effects of exercise adherence on physical function among overweight older adults with knee osteoarthritis. *Arthritis Rheum* 2005; **53**: 24–32.
13. Messier SP, Gutekunst DJ, Davis C, DeVita P. Weight loss reduces knee-joint loads in overweight and obese older adults with knee osteoarthritis. *Arthritis Rheum* 2005; **52**: 2026–32.
14. Focht BC, Rejeski WJ, Ambrosius WT, Katula JA, Messier SP. Exercise, self-efficacy, and mobility performance in overweight and obese older adults with knee osteoarthritis. *Arthritis Rheum* 2005; **53**: 659–65.
15. Hurley MV, Walsh NE, Mitchell HL, Pimm TJ, Williamson E, Jones RH *et al*. Economic evaluation of a rehabilitation program integrating exercise, self-management, and active coping strategies for chronic knee pain. *Arthritis Rheum* 2007; **57**: 1220–9.
16. Hurley MV, Walsh NE, Mitchell HL, Pimm TJ, Patel A, Williamson E *et al*. Clinical effectiveness of a rehabilitation program integrating exercise, self-management, and active coping strategies for chronic knee pain: a cluster randomized trial. *Arthritis Rheum* 2007; **57**: 1211–9.
17. National Institute for Health and Clinical Excellence. *Osteoarthritis: The care and management of osteoarthritis in adults*. <www.nice.org.uk> [accessed 20 May 2009].
18. Hurley MV. The role of muscle weakness in the pathogenesis of osteoarthritis. *Rheum Dis Clin North Am* 1999; **25**: 283–98.
19. Slemenda C, Heilman DK, Brandt KD, Katz BP, Mazzuca SA, Braunstein EM *et al*. Reduced quadriceps strength relative to body weight: a risk factor for knee osteoarthritis in women? *Arthritis Rheum* 1998; **41**: 1951–9.
20. Iwamoto J, Takeda T, Sato Y. Effect of muscle strengthening exercises on the muscle strength in patients with osteoarthritis of the knee. *Knee* 2007; **14**: 224–30.
21. Bennell KL, Hinman RS, Metcalf BR, Buchbinder R, McConnell J, McColl G *et al*. Efficacy of physiotherapy management of knee joint osteoarthritis: a randomised, double blind, placebo controlled trial. *Ann Rheum Dis* 2005; **64**: 906–12.
22. Quilty B, Tucker M, Campbell R, Dieppe P. Physiotherapy, including quadriceps exercises and patellar taping, for knee osteoarthritis with predominant patellofemoral joint involvement: randomized controlled trial. *J Rheumatol* 2003; **30**: 1311–7.
23. Ballantyne PJ, Gignac MA, Hawker GA. A patient-centered perspective on surgery avoidance for hip or knee arthritis: lessons for the future. *Arthritis Rheum* 2007; **57**: 27–34.
24. Sanders C, Donovan JL, Dieppe PA. Unmet need for joint replacement: a qualitative investigation of barriers to treatment among individuals with severe pain and disability of the hip and knee. *Rheumatology* 2004; **43**: 353–7.
25. Turner AP, Barlow JH, Buszewicz M, Atkinson A, Rait G. Beliefs about the causes of osteoarthritis among primary care patients. *Arthritis Rheum* 2007; **57**: 267–71.
26. Wang Y, Wluka AE, English DR, Teichtahl AJ, Giles GG, O'Sullivan R *et al*. Body composition and knee cartilage properties in healthy, community-based adults. *Ann Rheum Dis* 2007; **66**: 1244–8.
27. Marks R. Obesity profiles with knee osteoarthritis: correlation with pain, disability, disease progression. *Obesity* 2007; **15**: 1867–74.
28. Ding C, Cicuttini F, Scott F, Cooley H, Jones G. Knee structural alteration and BMI: a cross-sectional study. *Obes Res* 2005; **13**: 350–61.
29. Niu J, Zhang YQ, Torner J, Nevitt M, Lewis CE, Aliabadi P *et al*. Is obesity a risk factor for progressive radiographic knee osteoarthritis? *Arthritis Rheum* 2009; **61**: 329–35.
30. Felson DT, Goggins J, Niu J, Zhang Y, Hunter DJ. The effect of body weight on progression of knee osteoarthritis is dependent on alignment. *Arthritis Rheum* 2004; **50**: 3904–9.
31. Yip YB, Sit JW, Wong DY, Chong SY, Chung LH. A 1-year follow-up of an experimental study of a self-management arthritis programme with an added exercise component of clients with osteoarthritis of the knee. *Psychol Health Med* 2008; **13**: 402–14.
32. Axford J, Heron C, Ross F, Victor CR. Management of knee osteoarthritis in primary care: pain and depression are the major obstacles. *J Psychosom Res* 2008; **64**: 461–7.
33. Lin EH, Katon W, Von Korff M, Tang L, Williams Jr JW, Kroenke K *et al*; IMPACT Investigators. Effect of improving depression care on pain and functional outcomes among older adults with arthritis: a randomized controlled trial. *JAMA* 2003; **290**: 2428–9.
34. Kijowski R, Blankenbaker D, Stanton P, Fine J, De Smet A. Arthroscopic validation of radiographic scales of osteoarthritis of the tibiofemoral joint. *AJR Am J Roentgenol* 2006; **187**: 794–9.