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Analysis of a 1:1 physiotherapy outpatient intervention post primary lumbar discectomy

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Title

Analysis of a 1:1 physiotherapy outpatient intervention post primary lumbar discectomy

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ABSTRACT

Objective

There is a lack of high quality evidence for physiotherapy post lumbar discectomy. Substantial heterogeneity in treatment effects may be explained by variation in quality, administration, and components of interventions. An optimised physiotherapy intervention may reduce heterogeneity and improve patient benefit. The objective was to describe, analyse and evaluate an optimised 1:1 physiotherapy outpatient intervention for patients following primary lumbar discectomy.

Design

A descriptive analysis of the intervention embedded within an external pilot and feasibility trial.

Setting

Two UK spinal centres.

Participants

Participants aged ≥ 18 ; post primary, single level, lumbar discectomy were recruited.

Intervention

The intervention encompassed education, advice, mobility and core stability exercises, progressive exercise, and encouragement of early return to work/activity. Patients received ≤ 8 sessions for ≤ 8 weeks, commencing 4 weeks post surgery (baseline).

Outcomes

Blinded outcome assessment at baseline and 12 weeks (post intervention) included the Roland Morris Disability Questionnaire. STarTBack data were collected at baseline. Statistical analyses summarised participant characteristics and pre-planned descriptive analyses. Thematic analysis grouped related data.

Findings

Twenty two of 29 allocated participants received the intervention. STarTBack categorised n=16 (55%) participants 'not at low risk'. Physiotherapists identified reasons for caution for 8 (36%)

participants, commonly risk of overdoing activity (n= 4, 18%). There was no relationship between STarTBack and physiotherapists' evaluation of caution. Physiotherapists identified 154 problems (mean(SD) 5.36(2.63)). Those 'not at low risk', and/or requiring caution presented with more problems, and required more sessions (mean(SD) 3.14(1.16)).

Conclusions

Patients present differently and therefore require tailored interventions. These differences may be identified using clinical reasoning and outcome data.

Keywords

Lumbar discectomy, physiotherapy, clinical reasoning, STarT Back

Funding statement

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Competing Interests Statement

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Article summary

Strengths and limitations of this study

- The study employed a rigorous process to analyse and evaluate an optimised 1:1 physiotherapy outpatient intervention for patients following primary lumbar discectomy
- To reflect current practice, the 9 item STaRT Back may have been more valuable to avoid reducing the tool's discriminative power
- Although specific interventions were indicated as utilised, free text sections were often left unanswered thereby limited depth of information gained, perhaps reflecting the increasing demands placed upon NHS physiotherapists
- The study conclusions are limited by the low numbers of patients but some valuable insights can now be used to develop further work

Word count

3604 words

INTRODUCTION

With a lifetime prevalence of 80%, low back pain (LBP) represents a considerable health issue [1] with extensive financial (estimated £10,668 million annually) and societal cost. [2] Surgical management is the largest single component of expenditure, with lumbar discectomy a common procedure to excise part of a prolapsed intervertebral disc for a primary indication of leg pain. [3] Data supports high numbers of patients undergoing surgery, with 8,478 operations performed within the UK National Health Service (NHS) in the 2013/2014 year; [4] and annual estimates of 12,000 in the Netherlands, [5] and 287,122 in the USA. [6] Lumbar discectomy is considered effective, with documented success of 46-75% at 6-8 weeks, and 78-95% at 1-2 years post surgery. [3]

However, evidence suggests ongoing disability for some patients, with 70% fit to return to work 12 months after surgery [7] and 30-70% experiencing residual pain. [8] Re-operation is also an issue, estimated as 3-12% patients in the Netherlands, [9] and 14% in the UK. [4] With a low mean working age of 45 years for patients undergoing surgery and short mean hospital stay of 2.3 days, [4] post-operative outpatient rehabilitation is a key issue.

Post-operative advice and rehabilitation is variable from surgeon [10] and physiotherapist perspectives. [11] In some spinal centres (44%), individual out-patient physiotherapy is provided for all patients, and in others only for patients experiencing residual problems (further 46% centres). [11] Content and advice of physiotherapy management was variable, with 1-20 sessions and a wide range of interventions advocated.

Our systematic review [12] focused on the effectiveness of physiotherapy outpatient intervention post first single level lumbar discectomy. Only 1/16 included trials was low risk of bias, and only 3

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3 trials investigated individualised physiotherapy outpatient management, reflective of current
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5 practice [11] in several countries including the UK. The others investigated group management.
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7 Evidence was inconclusive overall. Some evidence suggested physiotherapy improved disability, with
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9 a potential benefit of more intensive intervention; and weak evidence suggested improved
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11 movement/physical impairment; all in the short-term. The findings mirrored a recently updated
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13 Cochrane review that investigated effectiveness of rehabilitation programmes that included
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15 physiotherapy. [3] Only 10/22 included trials were low risk of bias. Of interest, is a potential positive
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17 effect of exercise on pain and function; with very low/low quality evidence supporting high > low
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19 intensity exercise programmes short term, and low quality evidence supporting physiotherapy
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21 commencing at 4-6 weeks compared to no treatment/education only. The evidence from their
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23 previous review [13] of n=14 trials had been stronger, with low to moderate evidence supporting
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25 effectiveness of exercise compared to no treatment, and high intensity exercises as more effective
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27 than low intensity for pain and improved physical impairment.
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33 These data raise questions regarding optimal rehabilitation. An adequately powered low risk of bias
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35 trial is required to identify whether individualised physiotherapy is effective/cost effective.
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37 Substantial heterogeneity in treatment effects across all systematic reviews could be explained by
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39 variation in quality, administration, and components of interventions, illustrated by the documented
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41 variability in management and advice. [10,11] Therefore, prior to planning a trial, an optimised 1:1
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43 physiotherapy outpatient intervention was developed through a rigorous process [14] to reflect best
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45 practice, with flexibility to tailor management to individual patients in line with MRC guidance
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47 regarding the development of complex interventions. [15] The intervention was evaluated through
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49 an external pilot and feasibility study [16] that enabled description and analysis of the intervention
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51 and physiotherapist decision making.
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Objective

To describe, analyse and evaluate application of the optimised 1:1 physiotherapy outpatient intervention for patients following primary lumbar discectomy.

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METHODS

Design and setting

A descriptive analysis of the optimised 1:1 physiotherapy outpatient intervention embedded within an external pilot and feasibility study in preparation for a RCT reported elsewhere. [16] This was a small scale parallel RCT design, randomising consenting patients across two UK sites, the Queen Elizabeth Hospital Birmingham (QEHB) and the Salford Royal Foundation Trust (SRFT) to either the optimised intervention including patient leaflet or patient leaflet alone.

Participants

Eligibility criteria

Patients aged >18 years; post primary, single level, lumbar discectomy (including microdiscectomy), [17] and able to communicate in English. Exclusion criteria: previous surgery at same spinal level; co-morbidities that might impact on ability to participate in interventions including cauda equina compression, cognitive dysfunction, uncontrolled cardiovascular disease, [17] osteoporotic fracture, spondylolisthesis, multiple sclerosis, tumour; [18] complications from surgery; [17,19] and participation in a concurrent trial.

Recruitment

Patients were invited to participate prior to discharge. Interested and eligible patients were provided with a Participant Information Sheet, their questions answered, and asked to provide written consent to be contacted with an appointment 4 weeks post surgery. The patient leaflet was

provided and discussed. At 4 weeks, written informed consent was gained from eligible patients, and patients were randomised. The patient leaflet is described elsewhere. [20]

Ethical approval

R&D approval was gained. The West Midlands – Solihull Research Ethics Committee granted ethical approval (Ref: 12/WM/0224).

Physiotherapy intervention

The 1:1 physiotherapy outpatient intervention (Supplementary file) encompassed education, advice, mobility exercises, core stability exercises, a progressive approach to exercise to increase intensity, and encouragement of early return to work/activity. It was designed [14] to reflect best practice, based on current evidence. [10-13] It was developed and agreed by the research team following consultation with clinical experts and spinal surgeons at 5 spinal centres, physiotherapists and patients. This ensured an intervention informed by the evidence base that discouraged the use of treatments for which there is evidence of no effect. Although developed prior to the recently updated Cochrane review, [3] the intervention remains consistent with best evidence. Patients could attend ≤8 physiotherapy sessions ≤8 weeks, allowing patient choice and local practice variation.

The intervention commenced 4 weeks post surgery to provide optimal care. [3,12] Firstly, a list of guiding principles provided the basis for and guided the individual physiotherapist’s decisions for selecting treatment content, dose and progression etc. Secondly, a table of dual purpose provided a 1] description of the intervention and 2] structure to enable physiotherapists to record the delivered intervention. In line with MRC guidance, [15] the intervention incorporated flexibility to tailor management to individual patients needs following the physiotherapist’s assessment of the

individual patient and identification of their problems; ensuring patient centred care based on clinical reasoning. Physiotherapy clinical reasoning is complex and many trial interventions fail to capture and describe these processes. The developed intervention was acceptable to patients and clinicians. [14,16]

Demographic data and outcome assessment

Blinded outcome assessment was 4 weeks after surgery (baseline), and following intervention at 12 weeks post baseline (primary end point). Demographic data including age, gender, duration of symptoms prior to surgery, planned or emergency surgery, presence of leg and/or back pain, analgesia, employment status, and ethnicity were collected to describe participant characteristics. The primary outcome was the Roland Morris Disability Questionnaire, and the choice of secondary measures was informed by patients, surgeons, and physiotherapists: Global Perceived Effect (1=completely recovered, 2=much improved, 3=slightly improved, 4=not changed, 5=slightly worse, 6=much worse and 7=worse than ever compared with pre-surgery), Visual Analogue Scale leg pain and back pain (0-10cm, with 0 "no pain" and 10 "worst pain ever"), EQ-5D 5L, time to return to work/normal function/full duty, Tampa Scale for Kinesiophobia (17 items, each rated as 1 "strongly disagree", 2 "disagree", 3 "agree", or, 4 "strongly agree", total score out of 68), Fear Avoidance and Beliefs Questionnaire (16 items rated 0-6 informing 2 subscales: FABQ physical activity total score 24, and FABQ work 42), Straight Leg Raise, range of lumbar movement, analgesia, and re-operation. [16] Adherence was measured.

The Keele STarT Back Tool was also part of data collection at baseline. [21] It was developed for patients presenting with LBP in primary care to inform stratification of care based on identification of barriers to recovery. The tool possesses high reliability, [21] and validity compared to the Örebro

Musculoskeletal Pain Screening Questionnaire. [22] Researchers have investigated the predictive value of STarT Back in secondary care, in physical therapy clinics in USA [23,24] and Danish specialist care; [25,26] finding it less effective than in primary care, but equivalent to other measures such as pain intensity or activity limitation. The 6-item tool was used for consideration of participant questionnaire burden (referred leg pain, disability, catastrophising, depression and overall impact items) that stratifies patients into low risk/not at low risk of poor outcome. It has not been validated in a post-operative population and was therefore used descriptively.

Physiotherapists

Eligible treating physiotherapists were any band (grade) and working within the outpatient department. They were blinded to baseline STarT Back and outcome measure data. Training (AR/PG) standardised intervention delivery and answered questions.

Detail of intervention data collection

Physiotherapists and service users informed the development of the data collection tool that enabled capture of key components of the physiotherapy assessment to inform delivery of the intervention [14] (Supplementary file).

Data Analysis

Data were transferred to SPSS (version 21, IBM, New York, NY) and all data were checked to ensure their integrity. Statistical analyses included a summary of participant characteristics and pre-planned descriptive analyses. Thematic analysis was used to group related data [27] to enable descriptive analysis that explored: demographics, treatment detail and whether physiotherapists identified a

need for caution (aspects of clinical reasoning), and STarT Back data; in the context of treatment duration, frequency of interventions, problems identified, number of sessions and discharge data.

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FINDINGS

Participants

The study ran from January 2013 to July 2014, inclusive of recruitment, intervention, outcome assessment and focus groups. Figure 1 presents the trial CONSORT diagram. Twenty nine patients were randomly allocated to the 1:1 physiotherapy and patient leaflet intervention (n=11 QEHB, n=18 SRFT), and their characteristics are detailed in Table 1.

Table 1: Baseline participant characteristics 1:1 physiotherapy /patient leaflet intervention group

Characteristic		n*	Participants
Gender (male : female)		29	17:12
Age in years (range, mean ± SD)		29	26-64, 44.04 ±9.79
Nature of surgery (planned : emergency)		29	26:3
Ethnic group	White Caucasian	28	25
	Other white background		1
	Indian		2
Employment status	Employed	28	15 (n=1 also part time student)
	Self-employed		8
	Unemployed		2
	Retired		2
	Other (teaching contract ending)		1
Income band	<£10,000	27	2
	£10,000-19,999		7
	£20,000-29,999		7
	£30,000-39,999		4
	£40,000-49,999		1
	£50,000-59,999		3
	£60,000-69,999		0
	>£70,000		3
Claims	Employer sick pay	29	13
	Statutory sick pay	29	6
	Disability living allowance	29	1
Duration of symptoms prior to surgery (mean months ±SD)		29	68.34 ±93.80
Returned to work		28	Yes 8 No 19 Not applicable 1

Duties	29	Full duties 3 Light duties 4 Not applicable 22
Full or part time working (Prior to surgery, 17 were full time, 6 part time and not applicable for 5 (missing data for 1))	29	Full time 6 Part time 2 Not applicable 21
Weeks returned to work (mean \pm SD)	28	3.81 (1.60)
Returned to normal activity (yes:no)	29	7:22
Weeks returned to normal activity (mean \pm SD)	27	3.21 (1.63)

*Some missing data

Most surgical procedures were planned and the mean age of participants reflects a working population with 83% participants working (employed/self employed). At the 4-week baseline 28% (n=8) were back at work. The mean duration of symptoms prior to surgery was 61 months. Table 2 illustrates the clinical presentation of participants. All participants presented with pain and the majority with leg pain (93%) prior to surgery. Paraesthesia and numbness were common. At baseline, participants presented overall as moderate disability and although pain was mostly of low severity at this point, most required analgesia. The median Global Perceived Effect of 2 reflected considerable improvement from the surgery, perhaps also reflected in the high health related quality of life scores. Patients presented with a high TAMPAs reflecting issues of kinesophobia.

Table 2: Clinical presentation of the individualised 1:1 physiotherapy outpatient intervention participants (baseline data)

Measure		n*	Participants
Duration of symptoms prior to surgery (mean months, ±SD)		29	68.34 ±93.80
Nature of symptoms prior to surgery n (%)	Back pain (number)	29	22 (76)
	Leg pain (number)	29	27 (93)
	Paraesthesia	29	18 (62)
	Numbness	29	21 (72)
	Weakness	29	14 (48)
	Cauda equina	29	4 (14)
Currently taking pain relief (yes:no)		28	22:6
Roland Morris Disability Questionnaire (range, mean, ±SD)		29	0 to 23, 10.52 ±5.94
Global Perceived Effect (median, interquartile range(IQR))		29	2, 1
VAS Back Pain (mean, ±SD)	Today	29	2.30 (1.80)
	Least in last 2/52	29	1.48 (1.31)
	Greatest in last 2/52	28	4.80 (3.06)
VAS Leg Pain (mean, ±SD)	Today	28	1.62 (2.13)
	Least in last 2/52	28	0.84 (1.55)
	Greatest in last 2/52	28	3.74 (2.93)
TAMPA (mean, ±SD)		29	40.48 (6.47)
FABQ physical activity (mean, ±SD)		27	13.15 (4.52)
FABQ work (mean, ±SD)		26	19.96 (11.15)
EQ5D 5L (VAS): Health today (mean ±SD)		29	71.61 (16.50)
EQ5D 5L (median (IQR) min, max)	Mobility	29	2 (1) 1,4
	Self-care	29	1 (1) 1,3
	Usual activities	29	3 (1.5) 1,5
	Pain/discomfort	29	3 (1) 1,4
	Anxiety/ depression	29	2 (1.5) 1,5
Range of movement degrees (mean, ±SD)	Flexion	29	3.54 (1.96)
	Extension	29	0.71 (3.40)
	Left side flexion	29	31.56 (17.96)
	Right side flexion	29	30.71 (17.89)
Straight leg raise test: angle of symptomatic leg (mean, ±SD)		29	66.64 (18.02)
Straight leg raise n (%)	Test positive	27	25 (86)
Straight leg raise test Limiting Factor n (%)	Pain	27	14 (48)
	Resistance	27	11 (38)
	Pain & Resistance	27	2 (7)

*Some missing data

The STarT Back data (Table 3) illustrate that n=16 (55%) participants scored ≥ 3 and would be categorised as not at low risk of chronicity/poor recovery and therefore physiotherapy would be recommended.

Table 3: Baseline STarT Back data individualised 1:1 physiotherapy outpatient intervention participants (n=29)

STarT Back item	n (%)
My back pain has spread down my leg(s) at some time in the last 2 weeks	19 (66)
I have only walked short distances because of my back pain	17 (59)
In the last 2 weeks, I have dressed more slowly than usual because of back pain	14 (48)
I feel that my back pain is terrible and it's never going to get any better	4 (14)
In general I have not enjoyed all the things I used to enjoy (number)	22 (76)
Overall, how bothersome has your back pain been in the last 2 weeks?	9 (31)
Number of participants scoring 3 or above – not at low risk of chronicity / poor outcome (criteria for referral to physiotherapy)	16 (55)
6 item STarT Back total score (median, interquartile range)	3 (2)

Of the n=29 participants allocated to the optimised intervention, n=22 received the intervention.

N=1 QEHB and n=6 SRFT did not receive the intervention (5 female, 2 male), and 5/7 were categorised not at low risk using STarT Back. No adverse events were reported and no participant required further surgery.

Treating physiotherapist assessment of n=22 participants who received the intervention

Eight participants (36%) had reasons for caution identified by the physiotherapists, the most common being at risk of overdoing activity (n= 4, 18%) through returning to work early (n=1), keen to return to heavy work/weight training (n=1), tendency to overdo exercise (n=1), and diagnosis of post-traumatic stress disorder, using training as a coping strategy (n=1). Other reasons included:

care with neural mobilisations as assessment of SLR exacerbated pain for 4 days, previous trauma and orthopaedic surgery left hip and right foot, and normal precautions. There was no relationship between STarT Back and the physiotherapist’s evaluation of caution (50% of those evaluated as requiring caution evaluated as low risk).

Physiotherapy diagnosis

Table 4 details the physiotherapy diagnoses grouped according to the nature of the diagnosis.

Table 4: Physiotherapist diagnosis

Nature of diagnosis	Specific detail from individual participants (n=22)
Broad diagnosis - mechanical low back pain	Mechanical LBP - resolving non-capsular disc lesion post surgery
	Mechanical LBP post surgery
Post-surgical diagnosis - microdiscectomy	6/52 post right sided L4/5 Microdiscectomy
	Right L4/5 Microdiscectomy
	Right L4/5 Microdiscectomy
	Left L5/S1 Microdiscectomy
	Residual LBP with slight increase pain left side post microdiscectomy
	Resolving Radicular pain post L4/5 microdiscectomy. Congenital scoliosis with rotation. Leg length discrepancy following surgery for right club foot and left hip dysplasia as child
	L5/S1 Microdiscectomy. Deconditioning post surgery
	L5/S1 microdiscectomy
	L5/S1 microdiscectomy with residual S1 weakness and decreased sensation
Post-surgical diagnosis - discectomy	Right L3 Decompression
	L4/5 discectomy, fenestration and laminectomy
	L45 discectomy
	L5-S1 Fenestration and Discectomy
	5/52 post left L5/S1 discectomy - residual stiffness
Diagnosis related to problems - presenting clinical problems	Post-op back stiffness, poor core stability
	Increased adverse neural tension into right leg, lumbar spine stiffness
	Post op stiffness 5/52 post surgery
	Post op stiffness
	Left facet tightness / stiffness
	Residual weakness right glut max and med

Participants' problems

Treating physiotherapists highlighted a total of 154 problems (mean 5.36, SD 2.63). Those categorised as STarT Back not at low risk, and those evaluated as requiring caution by physiotherapists presented with a greater number of problems. Patients with a greater number of problems required more treatment sessions (Table 5).

Table 5: Number of problems Identified by physiotherapists

		Mean no of problems	Standard deviation
All 22 participants		5.36	2.63
Male (n=15)		5.07	2.74
Female (n=7)		6.00	2.45
Age (missing data n=2)	<45 years (n=10)	5.50	2.59
	≥ 45 years (n=10)	5.40	2.55
StarT Back low risk (n=11)		4.36	2.16
STarT Back not at low risk (n=11)		6.36	2.77
Caution (n=8)		6.50	1.41
No Caution (n=14)		4.71	2.97
No of treatment sessions	1-3 sessions (n=13)	3.77	2.09
	4-6 sessions (n=9)	7.67	1.23

The identified clinical problems were detailed within the framework of the 1:1 physiotherapy intervention (Table 6). The most common problem was reduced trunk stabilisation.

Table 6: Number of participants presenting with each problem

Problem	No of participants with problem (n=22)
Reduced trunk stabilisation	20
Reduced spinal ROM	17
Inadequate knowledge to enable self management	16
Reduced conditioning / fitness	14
Reduced functional mobility	12
Pain	12
Reduced general strength	10
Reduced neural mobility	10
Reduced progress / plateau in improvement	4
Impaired recovery owing to psychological factors	2
Patient not responding to RX / deteriorating / complications	1

Table 7 details the treatments employed by physiotherapists to manage the identified problem.

Table 7: Treatment employed by the physiotherapists for the problems present in the n=22 participants

Problem (in order of treatment record)	No of participants with problem	Treatment employed by the treating physiotherapist	n	Details added by physiotherapists relating to the treatment (direct quotes)
Reduced functional mobility	12	Advice to gradually increase walking distance	12	Goal: be able to do 5 hour walk Already doing, encouraged to continue Walking 30 minutes currently; to increase as he feels able Regular short walks Speed up walking to make aerobic Advice to increase time walking and not worry about distance Progress walks from 3 per week to daily. Monitor stops during 2 mile walk Advised to slow down - build up of exercise gradually If no neurological pain as discussed in detail
		Advice re getting in and out of car	1	
		Walking activities	9	Restoration of normal walking pace to be monitored Discussion with patient - shoe raise as has altered gait due to leg length Walk regularly, especially on days when in meetings Gradually progress walking distance Regular short walks Discussed with patient - increase concentration on left foot position and foot control Treadmill Advised a day's hill walking up Scafell Pike is too much
		Stairs	2	28 stairs to flat. Does minimum 4 flights / day To aim for stairs with right leg leading
		Advice re how to manage foot drop	2	Tibialis anterior strengthening - no functional foot drop Monitor left mild foot drop
		Others	4	Encouraged use of exercise bike Return to gym, advice re bike, treadmill and stepper Calf strengthening Advice re gradual swimming and cycling
Reduced	16	Explanation of healing, pain,	15	Particularly around disc dehydration and nerve root mobility

knowledge to enable self management		recovery time, expectations of surgery		Explained still healing at 6 weeks Nerve damage recovery 4 months. Soft tissue healing 4-8 weeks Can start to increase activity at 6 weeks eg. side plank Need to be careful between 6-12 weeks. Neural recovery 4 months Time scales to return to heavy work and gym work discussed Nerve recovery time scale, bone healing 12 weeks Explain healing time frame and limits to safe return Discussed in session 2 as reason for increased calf ache
		Discussion of aims and expectations of treatment	15	Discussed return to normal activities Explained healing and time lines Resolve leg pain and increase functional activity Restore muscle power to full power Monitor increase in fitness and return to activity Improve lumbar extension. Improve core. Improve condition / stamina for return to work Return to activity and normal work and gym To monitor residual symptoms. Assess and manage core stability Possibility for full/partial recovery discussed with patient
		Discuss any anxieties and explore any fear avoidance issues	12	Vigilant re employing correct movement habit Patient not moving into flexion at all due to fear avoidance Work place return and activity practise to decrease anxiety Nil, patient need to be discouraged from overdoing it Mild fear of lumbar flexion Main anxiety is "will I return to golf?" Advice return re gym Post traumatic stress disorder - patient keen to return to high level activity immediately as a coping strategy Discuss fear avoidance Fear of flexion instilled by preoperative emphasis on extension
		Goal setting	7	(1) Walk 5 hours, (2) walk normal pace (3) Do housework thoroughly Independent with home exercise programme, return to gym, improve gait return to low level, high repetitions weight lifting at 8 weeks Return to work by 12 weeks

				Attempt to set more realistic recovery goals Return to rowing, gentle cycling. At 10-12 weeks golf / mountain biking
		Reinforcing functional advice from manual e.g. specific advice on driving, milestones etc	7	No heavy lifting 12 weeks to moderate activity. No mountain biking until 12 weeks No heavy lifting etc Advice neutral spine in function Advice on 6 week / 12 week mile stones Advice on rowing position, sitting and forward lean posture
		Discuss increasing activity and to plan to return to work (or normal activities) as soon as able	13	Already returned to work Advice regarding occupational hazards No plan to return to work yet but phased return discussed Assess ability to lift weight after 6 weeks post op Discussed with patient who has already returned to work - requires increased driving and sitting Walking, lifting Plan to build activity and to assess lifting techniques approx 12 weeks Time scales and work handling discussed with patient Phased return to work Decrease activity to enable healing time, no heavy or intense training Returned to sedentary job on day 4 post surgery
		Discuss return to work plan and encourage patient to actively consider job/requirements +/- begin discussions with employer regarding graded return	7	Practise work physical tasks in physiotherapy session Discuss with employer need for breaks and regular position change Increase walking Patient to consider alternative job roles Discussed pacing
		Advice on general activities/ increasing other cardiovascular exercise e.g. gym, swim, cycle etc	15	Discussed gym - cross trainer, bike, gentle increase weights as comfortable Gentle increase in activity and light cardiovascular gym work Can freely increase aerobic work Static bike, increase walking, stairs Advice on swimming alternate days Cross trainer, cycle and swim to start Return to controlled gym work post 12 weeks Advice to add bike to gym

				Advice on gentle cardiovascular exercises
		Advice re smoking and bone healing	0	
		Tailored lifting advice	6	Lifting posture and technique with a work place hoist Lifting heavy blocks on return to work
		Tailored postural advice	10	Sitting - forward / backward lean using hip, sit to stand Maintaining stable thorax / pelvis relationship through movements Maintaining neutral spine / pelvis during sit to stand etc Sitting, sit to stand Talked through neutral spine Flat back posture Given ergonomic advice sheet, pacing, regular breaks Sitting posture, forward lean sitting from hip, arm reach, head position
		Others	2	Advice re gentle scar massage Advice re anti-inflammatories as prescribed, and activity modification
Reduced spinal range of movement	17	Accessory movements e.g. posterior-anterior (PA) technique	10	Grade III PA mobilisations central / unilateral x 3 x 30 seconds PA grade III x 30 seconds PA grade III L3-5 Grade IV PA mobilisations central and unilateral right L3-5 PA L1-3 grade III, PA in extension L1-3 grade III Mobilised right L4,5,S1 to decrease pain on hip extension PA L2 to improve extension but minimal benefit. Better at 2nd session. Grade III x 3 x 30 sec Central PA L4/5 grade III, PA grade III left side L4/5 x 1 min, L4 right and left, L3 right and left, combined left side flexion PA L4-5 PA left side grade III L1,2,3,4 facet x 1 minute each
		Physiological movements / mobility exercises in weight bearing	8	Stretches in standing Lumbar spine stretches in standing Seated and standing range of movement Gentle weight bearing range of movement
		Physiological movements in non weight bearing	8	Lumbar spine active range of movement stretches in crook lying Reviewed current exercises Seated range of movement Lumbar extension

				To assess lumbar spine vertebral movement Active range of movement exercises
		Others	2	Soft tissue techniques and trigger point pressure to left quadratus lumborum Palpation and sacral mobilisation to assess neural interface and re-test SLR
Reduced trunk stabilisation	20	Transversus abdominis in neutral	17	Pelvic Tilt Pelvic Tilt Concept gained via explanation of mechanism and pelvic tilt Corrected technique Trans Abdominus setting in crook lying - very poor Supine crook transverses abdominus, pilates 100s exercise Pelvic Tilt Pilates 100 setting Crook lying Transversus abdominus neutral
		Gluteal exercises	12	Concept gained via explanation of mechanism and pelvic tilt Reviewed current bridging technique Hip extension in prone knee bend Clam and bridge Prone kneeling right hip extension Bridging Piriformis release and patient taught self massage Piriformis stretch and endurance
		Progression of transversus abdominis	11	To do whilst walking at gym. Pilates exercises second treatment. 100s level 1 Decreased control on right leg crook needs addressing prior to lifting 100s and transverses abdominus in sitting Bridge - ball. Single leg bridge With leg slides Flexion biased Position well maintained, therefore core approach not planned
		Non-specific core stability exercises	9	Sitting forward / backward, stand from wall Bridging

				In standing, forward and backward lean sitting Bridging and review of patients own exercises Core contraction in standing and gym ball as finds crook lying difficult Bridging and global core exercises Excellent balance on perturbation
		Multifidus retraining	1	Squat work
		Advanced trunk stabilisation	4	Bridge to 1/2 range: overuses spinal extensors beyond this Advice on gym ball and gym work Right side plank with left hip abduction Bridging and increased gluteal control. Higher end core work
		Others	4	Trunk stabilisation in sitting, standing, sitting to standing and lifting Correction of spinal curve in side lying Advise on return to gym Importance of core re prevent recurrence
Reduced general strengthening	10	Lower limb strengthening exercises	9	Resisted plantar flexion with green theraband x 15 reps per day increase / decrease as able. Toe raises second treatment session Calf raise and tibialis anterior strengthening Right gluteal strengthening Sit to stand with left foot forward. Stair climbing. Static bike Squats Ankle dorsi flexion active assisted range of movement and strength Isometric calf holds. Calf raises appointment no 2 Gluteal exercises Exercise bike, rower
		Upper limb strengthening exercises	1	Advice re lifting weights in gym
		Others	1	Treatment 2 - did not commence side plank as patient reported mild right leg symptom post exercise. Encouraged hamstring stretch
Reduced neural mobility	10	Specific cautious movements		SLR exacerbated pain for 4/7 at 1st assessment
		SLR performed actively	4	Using hamstring stretch in supine - progressing popliteal angle SLR stretch with dorsi / plantar flexion x30 sec x 3 per day - not into painful range
		SLR performed passively	3	SLR mobilisations For assessment mild adverse neural tension right leg

				Decreased SLR due to neural tension
		Active slump	5	Sitting, left knee extension and dorsi flexion. Replace leg swing with this For adverse neural tension and hamstring length For mild adverse neural tension Use as a treatment to increase neural mobility Pelvic tilts to exercise lower lumbar spine range of movement
		Passive slump	1	With SLR for adverse neural tension
		Others	3	Sitting, leg swing, increasing reps and frequency if not exacerbating pain Heel and leg slides for gentle decrease adverse neural tension Piriformis release and stretches. Passive range of movement and SLR
Reduced conditioning / fitness	14	Graded functional exercises	8	Walking Advice on return to gym and cycling Discussed with patient staged return to sport and golf Bike and cross trainer 10% increase distance per week Advised to decrease activity to pace and manage pain and healing Cycling - start at 3/52
		Paced increase in activity	5	Walking, housework Increase gym activity gradually Walking 3rd session boom/bust activity Session 2 - to start rowing action, progressing exercises accordingly
		General aerobic exercises	8	Encouraged continue with cross trainer and bike in gym, increase gradually Advised to use cardiovascular exercise in gym - treadmill and static bike At treatment 1 already exercising aerobically 2 hours / day Walking, stairs and static bike Discussed with patient gym work Advice on static bike cycling for cardiovascular and neural mobility Exercise bike and stepper Rowing, cycling
		General strength training	2	Continue with gentle upper limb and lower limb weights in gym Discussed with patient gym work
		Low intensity exercises	0	
		High intensity exercises	1	Treatment 2 Encouraged continue with present programme for further week

		Others	3	Weight lifting starting low level Muscle energy technique hamstrings, discussed nature of osteoarthritis Muscle energy technique hamstrings
Reduced progress / plateau in improvement	4	Continue with exercises independently at home	2	Home exercise programme from hospital. Was performing bridge incorrectly
		Short and longer term goal setting	2	Improved strength and condition – return to work Increase walking
		Planning for the future	1	Pilates
		Others	0	
Pain	12	Explanation of pain physiology	5	Explanation of referred pain
		Advice on pain relief and who to contact	4	General Practitioner review and neuropathic pain agents discussed with patient Discussed with GP re wean from Gabapentin
		Advice re when to stop taking pain killers	3	On paracetamol only
		Advice re how to manage flare ups	0	
		Pain control interventions e.g. Acupuncture, TENS	1	Piriformis release and acupuncture
		Others	3	Advice that intermittent pain nothing to worry about and pain is soft tissue healing Advice sensory stimulus to decreased ankle area Advice regarding preventing recurrence
Impaired recovery owing to psychological factors	2	Cognitive behavioural approach	0	
		Pacing	2	Advice pacing in gym
		Goal setting	1	Little and often rather than boom bust
		Others	0	
Patient not responding / condition deteriorating / experiencing complications	1	Liaise with surgical team to discuss case	0	
		Liaison with surgical team / colleagues	0	
		Others	1	Liaise with consultant re return to work

As treatment progressed, only 1 participant was documented with a problem of not responding/condition deteriorating/experiencing complications. This participant was not initially identified as requiring caution, but did present with the highest number of problems (n=9) and STarT Back not at low risk. Reduced progress/plateau in improvement was identified as a problem for 4 patients (n=2 were STarT Back not at low risk and n=1 had a problem of impaired recovery owing to psychological factors). Only 2 participants were evaluated as having a problem of psychological factors affecting recovery.

Number of treatment sessions

The mean (SD) number of treatment sessions was 3.14 (1.16), range of 1-6 (Figure 2). No participant required the maximum of 8 sessions. Table 8 illustrates that participants classified as STarT Back not at low risk, and participants requiring caution required a greater number of treatment sessions.

Table 8: Number of treatment sessions provided by physiotherapists

		Mean no of treatment sessions	Standard deviation
All 22 participants		3.14	1.61
Male (n=15)		3.07	1.58
Female (n=7)		3.29	1.80
Age (missing data n=2)	<45 years (n=10)	3.20	1.48
	≥ 45 years (n=10)	3.20	1.81
STarT Back low risk (n=11)		2.64	1.12
STarT Back not at low risk (n=11)		3.64	1.91
Caution (n=8)		4.00	1.85
No caution (n=14)		2.64	1.28

Participants demonstrated 100% adherence at 12 weeks, although the nature of adherence did vary and was affected by factors that included their motivation. Some participants reported exercising 3 times per day and others ‘as able to’ around other activities such as work or gym. Participants provided reasons for reducing their exercises including: pain, increasing other activities such as golf and walking, cycling, or returning to work; but also increasing exercises, for example exercising in response to days of increased pain.

Patient outcome data

Table 9 details the patient outcome data at baseline and at 12 weeks after completion of the optimised intervention.

Table 9: Outcome data at baseline (4 weeks post surgery) and 12 weeks (post intervention)

Outcomes		Baseline		12 weeks	
		n	Mean (SD)	n	Mean (SD)
Roland Morris Disability Questionnaire		29	10.52 (5.94)	17	5.53 (4.49)
VAS Back Pain	Today	29	2.30 (1.80)	17	2.20 (1.65)
	Least in last 2/52	29	1.48 (1.31)	17	1.70 (1.60)
	Greatest in last 2/52	28	4.80 (3.06)	17	4.34 (2.64)
VAS Leg Pain	Today	28	1.62 (2.13)	17	1.74 (2.13)
	Least in last 2/52	28	0.84 (1.55)	17	1.79 (2.50)
	Greatest in last 2/52	28	3.74 (2.93)	17	3.64 (2.82)
Tampa Scale for Kinesiophobia		29	40.48 (6.47)	17	37.35 (8.29)
Fear Avoidance and Beliefs Questionnaire physical activity		27	13.15 (4.52)	15	11.53 (7.73)
Fear Avoidance and Beliefs Questionnaire work		26	19.96 (11.15)	14	16.86 (12.48)
EQ5D 5L (VAS): Health today		29	71.61 (16.50)	17	70.06 (10.58)
Range of movement	Flexion	29	3.54 (1.96)	17	4.47 (1.49)
	Extension	29	0.71 (3.40)	17	1.64 (3.96)
	Left side flexion	29	31.56 (17.96)	15	35.59 (17.97)
	Right side flexion	29	30.71 (17.89)	15	32.49 (17.38)
Straight leg raise	Angle of symptomatic leg	29	66.64 (18.02)	17	80.53 (12.53)
		n (%)		n (%)	
Straight leg raise	Test positive	25 (86)		9 (53)	
Straight leg raise	Pain	14 (48)		4 (24)	

limiting factor	Resistance	11 (38)	9 (53)
	Pain & Resistance	2 (7)	0 (0)
	Missing	2 (7)	4 (24)
		n (%)	n (%)
Return to work	Yes	8 (28)	10 (59)
	No	19 (56)	5 (30)
	Not applicable	1 (3)	2 (12)
	Full time	6 (21)	8 (47)
	Part-time	2 (7)	2 (12)
	Not applicable	21 (72)	7 (41)
Type of duties on return to work	Full duties	3 (10)	7 (41)
	Light duties	4 (14)	3 (18)
	No or not applicable	22 (76)	7 (41)
Return to normal activities	Yes	7 (24)	11 (65)
	No	22 (76)	6 (35)
		N	Mean (SD)
Return to work: weeks post-surgery mean (SD)		8	3.81 (1.60)
Return to normal activities: weeks post-surgery		7	3.21 (1.63)
		n (median, IQR)	n (median, IQR)
Global Perceived Effect (median, range)		29 (2, 1)	16* (2, 0.75)

Note: IQR – interquartile range, * missing data)

For the primary outcome measure the RMDQ, sensitivity to change was assessed at 12 weeks with mean (SD) change -5.44 (4.84), 95% CI -8.02, -2.86 for the individualised 1:1 physiotherapy outpatient intervention.

Patient discharge data

Of the treating physiotherapists who included their assessment of the patient's status at discharge (n=12), all felt that the patient had improved. The data highlights that n=3 patients required further care (Table 10).

Table 10: Physiotherapist’s (n=12) summary of patient outcome and advice provided at discharge

	Physiotherapist’s summary
Improved to continue with self management	Commenced specific core exercises at treatment 3. Patient already practising bridging but was thrusting using spinal extensors and not performing movement correctly. This is a very common fault when bridging is not taught or monitored. 01/05/13 patient reports return to all normal activities - long walks, playing with grandchildren. Continues with neural mobilisation as minor residual tension present on right (SLR 70/70). Reports that she still relies on husband to carry shopping upstairs. Improvement from 32 to 16 on Oswestry.
	This patient reports a large improvement in symptoms - this was the case in the first assessment. She had followed all advice, had a good understanding of the healing process. She initially presented with numbness L5/S1 and intermittent calf pain and mild LBP, this had improved by her follow up appointment. She was happy to continue with her exercises and progress her activity at the gym independently.
	Treatment 2 - infected scar identified. Treatment 3 - scar normal appearance after receiving treatment. Undergoing investigations for bronchiectasis. Core issues identified and need to continue strengthening right gluteals / abdominals in right single leg stride prior to addressing side plank issue on right. This delayed progressing gym activities including weight resisted exercises. Treatment 4 - complaining of minor (1/10) ache right side scar and minor restriction right hamstrings. Otherwise has made excellent progress with normal restoration of function and progressing exercise tolerance to a high level.
	Patient has returned to work on full duties. Patient is driving with no problems. Resolved adverse neural tension, no measurable right leg weakness. Patient does complain of mild tenderness at times over scar. Patient independent with basic core exercise programme and has been advised on a graded return to her previous exercise level. Patient advised to avoid heavy lifting and mountain biking until 12/52 post op. Good functional range of movement and power. Patient can independently return to cardiovascular fitness and is happy to do this independently. Patient required advice on activity progression to ensure she did not progress too quickly and risk tissue healing.
	Reasonable outcome post surgery. Significant improvement. Discharged with self management advice / education.
	Patient was independent with his exercises and keen to increase his strengthening work. Lumbar spine mobility had improved but he did have a residual weakness in the left lower limb with dorsiflexion and great toe extension. This was not enough to justify use of a foot drop splint = 4/5. His long standing postural issues were ongoing. Pain had resolved and was not an issue. Patient had an extended scope practitioner review booked and would look to be re-referred to physiotherapy at this stage if required.
	This patient has returned to high level gym exercise 4-5 x a week but not yet returned to work as it involves very heavy lifting and wants to discuss with consultant. I have given all the relevant advice.
	On 3rd session patient reported that only symptom was an awareness of mild tension left calf. No neurological signs. He has resumed all usual activities including cycling and rowing. Failed to attend last appointment and did not respond to my message to make contact. No concerns - therefore discharged.

Required further care	Patient returned to independent gym activity. Patient has decreased leg pain post op but some increased lumbar spine pain. Patient has congenital postural issues which have not been addressed with this episode of care. Patient would benefit from further strengthening and a podiatry referral for leg length discrepancy. Advised to seek via General Practitioner. Patient independent with spinal home exercise programme and has returned to previous level of activity with good reduction of pain.
	14/08/13 patient reports 1 episode of frank incontinence, similar but more severe than the frequent but inconsistent episodes of mild incontinence pre-op. Letter to consultant recommending urodynamic testing after discussion with Clinical Specialist. 20/08/13 minor right sided LBP. Lumbar range of movement restored. Remains de-conditioned with decreased core control and would benefit from further encouragement to pursue daily exercise. Not yet back at work - fearful that work pressure might prevent phased return (nurse).
	Patient reports pain decreased from 8/10 to 4/10. Patient has residual S1 weakness and reduced sensation. Patient has a tendency to push too hard and set unrealistic goals, partly due to coping strategy of exercise with post traumatic stress disorder. Patient regularly hill walking over 12 miles. He remains with neural tension, but is managing well. When he fatigues he complains of increased S1 weakness. He is to be referred to his local physiotherapist for ongoing management and progression.
Did not attend	Patient unfortunately unable to attend several appointments and then did not attend. Tried to contact to follow up but no contact. Patient therefore discharged. Patient contacted department 19/09/13 and was informed to contact GP for re-referral.

DISCUSSION

Participants

The mean duration of symptoms prior to surgery of 68 months is substantial and illustrates the chronic nature of patients. Their clinical presentation was characteristic of disc problems affecting the nerve roots with all patients presenting with pain and the majority with leg pain (93%); most accompanied with paraesthesia and numbness. The mean age of participants of 44 years emphasises the importance of returning to work/function. The demographic profile closely resembles the populations in existing clinical trials, [3,12] and wider UK data. [4]

At 4 weeks post surgery (optimal intervention timing) [3,12] in the sub-acute stage of healing, participants were characterised by moderate disability (mean RMDQ 10.52), and although pain was of overall low severity, most still required analgesia. There was considerable variability in disability (range 0-23, SD 5.94) highlighting heterogeneity of this population. While the median GPE of 2 and high health related quality of life scores reflected considerable improvement from surgery, participants did present with high kinesiphobia. The mean TAMPA of 40.48 (SD 6.47) was ≥ 37 , the recommended cut-off. [28] This may reflect a lack of confidence in returning to function following surgery. In contrast, the mean(SD) FABQ activity score of 13.15(4.52) and FABQ work of 19.96 (11.15) were not elevated according to preliminary data regarding cutoff scores. [29,30] These differences are interesting as some overlap between these two measures in a chronic LBP population is proposed, and a strong relationship exists between disability and increased FABQ. [31]

Use of STarT Back suggested that 55% of participants required physiotherapy being evaluated not at low risk of poor outcome. Physiotherapy evaluation designated other patients as requiring caution in their management, and others with multiple problems that were not detected using STarT Back. Leg

pain – a question on STarT Back is the main indicator for lumbar discectomy and so this may have affected the data, reflecting an obvious limitation of STarT Back in this population. Interestingly, 5/7 patients who did not attend for physiotherapy were classified as low risk of poor outcome which may have informed their decision not to attend. This is the first time the STarT Back tool has been used in secondary care with post-operative patients, as previous secondary care studies excluded post-operative patients [23] or included a broad range of conditions. [24,26] The STarT Back tool has less predictive ability in secondary care but its performance equals alternative measures. [26] Overall, STarT Back may therefore be useful in combination with other factors to inform decisions regarding patients that require more than minimal physiotherapy intervention.

Physiotherapist clinical reasoning

Diagnosis and caution

Physiotherapists used a range of diagnostic categories following their assessment of patients, with most focused to the surgical procedure, distinguishing discectomy, microdiscectomy and level of procedure; reflecting a biomedical approach. The most common levels were low lumbar specifically L_{4,5}, S₁. Physiotherapists designated n=8 participants as requiring caution, the main reason being a risk of overdoing activity at a time when tissues are still healing; and this evaluation did not reflect STarT Back. This does suggest, unsurprisingly that STarT Back is not focused on all relevant issues for this population, and that the intervention framework facilitated further discrimination between patients.

Participants' problems

The mean of 5.36 (SD 2.63) problems highlighted the substantive issues still experienced by participants 4 weeks following surgery. The higher number of problems was consistent with the physiotherapist reasoning around caution and STarT Back not at low risk. The nature of the identified problems reflected the chronicity and complexity of patients undergoing surgery, and therefore the requirement of intervention to support their ability to self-manage. The nature of problems reflected a focus on function with the key issues being muscle strength, range of movement, general conditioning and fitness.

Physiotherapy treatment

Clarity of a framework for the intervention [15] perhaps contributed to a consistent approach to physiotherapy management that did not reflect previously identified variability. [11] Treatments reflected an emphasis on education, advice and progressing activity and function, with the use of manual therapy, specific exercises, and general exercise interventions. Reduced neural mobility was identified as a problem for n=10 participants but few specific treatment interventions were implemented; suggesting that neural symptoms resolved through other interventions/time. There was an emphasis on progression of management, for example, exercises for an individual, but not the emphasis on high intensity exercises within the literature; [3,12] perhaps limited by the exclusion of exercise class interventions in this study. Psychological issues were only identified for n=2 participants and so psychologically informed interventions were not widely used (cognitive behavioural approaches, pacing or goal setting). This suggests that physiotherapists were happy using education, advice and other interventions to address kinesiophobia. The number of physiotherapy sessions ranging 1-6 was not reflective of the UK survey of 1-20 sessions. [11] The physiotherapists reasoned that participants with a greater number of problems, or in situations where caution was required, needed a greater number of sessions.

Outcome data

The data demonstrate that participants improved in most outcomes by 12 weeks. In particular, the return to work data was promising with 59% participants back at work and 65% back to usual activities by 12 weeks compared to 28% and 24% at baseline. This compares to 70% fit to return to work 12 months after surgery. [7] For the RMDQ, sensitivity to change at 12 weeks was promising (mean(SD) change -5.44(4.84), 95% CI -8.02, -2.86). These positive outcomes were reflected in the physiotherapists' discharge summaries. Physiotherapists identified that n=3 participants required further management, identifying a small number of participants who required greater intervention than the defined parameters. Although improved, an issue that requires further consideration is kinesiophobia as at 12 weeks the TAMPA remained close to the ≥ 37 cut-off. [28]

Limitations

While some potentially interesting differences between participants are highlighted and areas for further investigation identified, it is difficult to draw meaningful conclusions from this data owing to the low number of participants. To reflect current practice, the 9 item STarT Back may have been more valuable to avoid reducing the tool's discriminative power. [25] Although specific interventions were indicated as utilised, free text sections were often left unanswered thereby limited depth of information gained. It is difficult to establish whether this represents a training issue regarding data collection, or the increasing demands placed upon NHS physiotherapists. The wide inclusion of all bands of physiotherapist with some less experienced in managing this population may also have contributed to these issues.

CONCLUSIONS

These data suggest that patients present differently post lumbar discectomy and therefore require different interventions. These differences can be identified by clinical reasoning and a tool such as STarT Back, although the congruence between the two merits further consideration. The crux of this issue is the identification and targeted treatment of patients to ensure that patients at low risk of poor outcome are not over treated and patients not at low risk of poor outcome are not under treated. This is a key issue in this climate of austerity and the move towards more resourceful healthcare, improving quality and safety, and minimising costs by avoiding unnecessary treatment.

[32]

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Authors' contributions

AR and PG are Senior Lecturers in physiotherapy and NH is a lecturer in physiotherapy. MC is a Professor of outcomes methodology. AC, AH and LW are clinical specialists and extended scope practitioners working in spinal surgery. AR, PG, NH, AC, AH and LW have long-standing professional interests in the rehabilitation of patients following spinal surgery, and all have a professional focus to musculoskeletal physiotherapy. AR, PG, AH and LW were responsible for the conception of the study. AR, MC, PG and NH were responsible for the design and methodology. AR, AC and NH were responsible for the data analysis. All authors have contributed to the study and have been involved in developing the content of the article. AR and AC wrote the first draft of the paper. AR has worked with all authors reworking content into subsequent drafts. All authors gave final approval of the version to be published. AR is the guarantor.

Data sharing statement

No additional data available.

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Figure 1: CONSORT DIAGRAM (Period 14.01.13 to end of study)

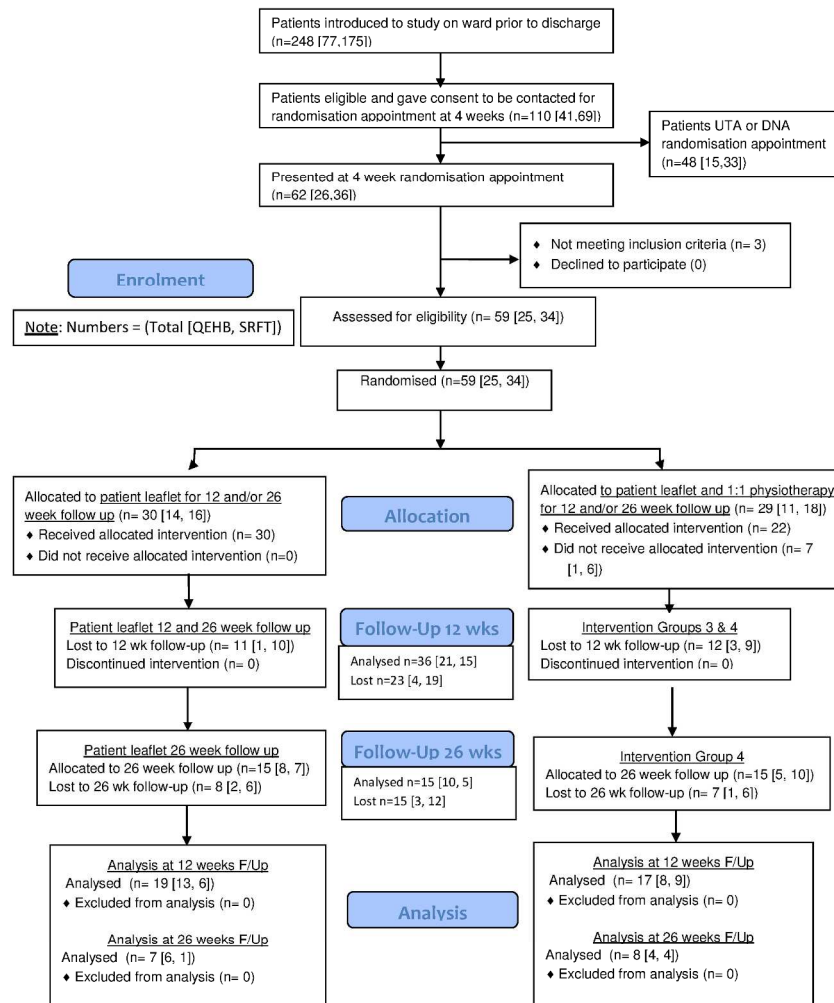


Figure 1: CONSORT DIAGRAM

215x279mm (300 x 300 DPI)

Figure 2: Number of treatment sessions

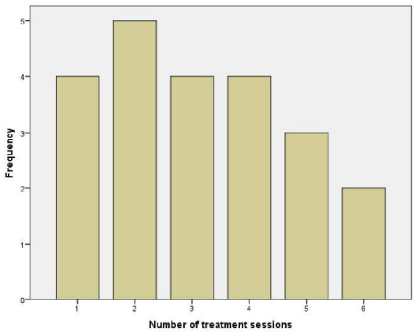


Figure 2: Number of treatment sessions

215x279mm (300 x 300 DPI)

Supplementary file

Physiotherapy treatment

Principles

[These principles are intended to provide the basis for and guide the individual physiotherapist's decisions for selecting treatment content, and deciding dose and progression of treatment etc].

1. To provide a framework and, thereby, some standardisation for clinical decision-making for physiotherapists.
2. To enable flexibility of the intervention for the individual patient, to ensure patient centred practice.
3. To enable treatment according to assessment findings of the individual patient, through flexibility of the intervention.
4. To commence the intervention at approximately 4 weeks post surgery, to provide optimal care.
5. To allow for patient choice and variations in practice by delivering up to 8 physiotherapy sessions for each patient, over a period of up to 8 weeks (taking the patient up to 12 weeks post surgery).
6. To decide the number of contacts required, nature of the intervention, and speed of progression based on an initial assessment (and refined by subsequent re-assessment as appropriate).
7. To apply the intervention to patients alongside use of the post lumbar discectomy manual.
8. To use individualised goal setting as a strategy to guide progression.
9. To consider high intensity exercise for patients for whom this might be slightly more effective than low intensity for pain and improved functional status. Intensive interventions include approaches to physiotherapy through exercise, behavioural rehabilitation, or a multimodal approach. High intensity can be defined in terms of repetitions, effort, difficulty etc.
10. To follow a progressive approach to exercise with encouragement of early return to work and activity (or a graded return to work for those with jobs involving higher physical demands), to be in line with optimal care.

Table detailing the proposed 1:1 intervention

Table of dual purpose – to provide 1] a description of the intervention and 2] a structure to enable physiotherapists to record the delivered intervention.

Instructions:

- Following your initial examination of the patient, please complete the first 4 sections of the table from ‘participant number’ to ‘problem list’.
- For the first session please also detail under physiotherapy session 1 your interventions.
- For subsequent visits, please detail under the relevant session number your interventions.
- At discharge please complete the final ‘discharge’ box.
- At discharge, please reinforce that further support would be via their GP.
- The table is to document what you have done NOT to guide you in way as to what you should do.
- The list of interventions covers every intervention you might want to use, not what you should use.

Participant number:			
Physiotherapy diagnosis:			
Any reasons for caution:			
Problem list:	Problem	Session problem added (1-8)	Session problem resolved (1-8)
	1.		
	2.		
	3.		
	4.		
	5.		
	6.		
	7.		

	8.								
	9.								
	10.								
PROBLEM	Treatment intervention options <i>(under 'detail', please provide information regarding specific techniques, dosage, progression etc)</i>	Number of physiotherapy session <i>(please tick the intervention used for each physiotherapy session)</i>							
		1	2	3	4	5	6	7	8
		Please insert dates of physiotherapy sessions under the number of the session							
Reduced functional mobility	Advice to gradually increase walking distance <i>Detail:</i>								
	Advice re getting in and out of car <i>Detail:</i>								
	Walking activities <i>Detail:</i>								
	Stairs <i>Detail:</i>								
	Advice re how to manage foot drop <i>Detail:</i>								
	Other - please detail								
Reduced knowledge to enable self management	Explanation of healing, pain, recovery time, expectations of surgery <i>Detail:</i>								
	Discussion of aims and expectations of treatment <i>Detail:</i>								

	Discuss any anxieties and explore any fear avoidance issues <i>Detail:</i>								
	Goal setting <i>Detail:</i>								
	Reinforcing functional advice from manual e.g. specific advice on driving, milestones etc <i>Detail:</i>								
	Discuss increasing activity and to plan to return to work (or normal activities) as soon as able <i>Detail:</i>								
	Discuss return to work plan and encourage patient to actively consider job/requirements +/- begin discussions with employer regarding graded return <i>Detail:</i>								
	Advice on general activities/ increasing other CV exercise e.g. gym, swim, cycle etc <i>Detail:</i>								
	Advice re smoking and bone healing <i>Detail:</i>								
	Tailored lifting advice <i>Detail:</i>								
	Tailored postural advice <i>Detail:</i>								
	Other - please detail								
Reduced spinal range of	Accessory movements e.g. PA technique <i>Detail:</i>								

movement	Physiological movements / mobility exercises in weight bearing <i>Detail:</i>								
	Physiological movements in non weight bearing <i>Detail:</i>								
	Other - please detail								
Reduced trunk stabilisation	Transversus abdominis in neutral <i>Detail:</i>								
	Gluteal exercises <i>Detail:</i>								
	Progression of transversus abdominis <i>Detail:</i>								
	Non-specific core stability exercises <i>Detail:</i>								
	Multifidus retraining <i>Detail:</i>								
	Advanced trunk stabilisation <i>Detail:</i>								
	Other - please detail								
Reduced general strengthening	Lower limb strengthening exercises <i>Detail:</i>								
	Upper limb strengthening exercises <i>Detail:</i>								
	Other - please detail								

Reduced neural mobility	Specific cautious movements								
	<i>Detail:</i>								
	SLR performed actively								
	<i>Detail:</i>								
	SLR performed passively								
	<i>Detail:</i>								
	Active slump								
Reduced conditioning / fitness	<i>Detail:</i>								
	Passive slump								
	<i>Detail:</i>								
	Other - please detail								
	Graded functional exercises								
	<i>Detail:</i>								
	Paced increase in activity								
	<i>Detail:</i>								
	General aerobic exercises								
	<i>Detail:</i>								
	General strength training								
	<i>Detail:</i>								
	Low intensity exercises								
	<i>Detail:</i>								
	High intensity exercises								
	<i>Detail:</i>								
	Other - please detail								

Reduced progress / plateau in improvement	Continue with exercises independently at home <i>Detail:</i>								
	Short and longer term goal setting <i>Detail:</i>								
	Planning for the future <i>Detail:</i>								
	Other - please detail								
Pain	Explanation of pain physiology <i>Detail:</i>								
	Advice on pain relief and who to contact <i>Detail:</i>								
	Advice re when to stop taking pain killers <i>Detail:</i>								
	Advice re how to manage flare ups <i>Detail:</i>								
	Pain control interventions e.g. Acupuncture, TENS <i>Detail:</i>								
	Other - please detail								
Impaired recovery owing to psychological factors	Cognitive behavioural approach <i>Detail:</i>								
	Pacing: <i>Detail</i>								
	Goal setting: <i>Detail:</i>								
	Other – please detail								

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Patient not responding /condition deteriorating / experiencing complications	Liaise with surgical team to discuss case								
	Detail:								
	Liaison with surgical team / colleagues								
	Detail:								
	Other - please detail								

Patient discharge:

Please summarise the outcome of physiotherapy at the point of discharge and any specific advice that you have given to the patient.

BMJ Open

Descriptive analysis of a 1:1 physiotherapy outpatient intervention post primary lumbar discectomy: one arm of a small scale parallel RCT across two UK sites

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Primary Subject Heading:	Rehabilitation medicine
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TITLE PAGE

Title

Analysis of a 1:1 physiotherapy outpatient intervention post primary lumbar discectomy

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ABSTRACT

Objective

There is a lack of high quality evidence for physiotherapy post lumbar discectomy. Substantial heterogeneity in treatment effects may be explained by variation in quality, administration, and components of interventions. An optimised physiotherapy intervention may reduce heterogeneity and improve patient benefit. The objective was to describe, analyse and evaluate an optimised 1:1 physiotherapy outpatient intervention for patients following primary lumbar discectomy, to provide preliminary insights.

Design

A descriptive analysis of the intervention embedded within an external pilot and feasibility trial.

Setting

Two UK spinal centres.

Participants

Participants aged ≥ 18 ; post primary, single level, lumbar discectomy were recruited.

Intervention

The intervention encompassed education, advice, mobility and core stability exercises, progressive exercise, and encouragement of early return to work/activity. Patients received ≤ 8 sessions for ≤ 8 weeks, commencing 4 weeks post surgery (baseline).

Outcomes

Blinded outcome assessment at baseline and 12 weeks (post intervention) included the Roland Morris Disability Questionnaire. STarTBack data were collected at baseline. Statistical analyses summarised participant characteristics and pre-planned descriptive analyses. Thematic analysis grouped related data.

Findings

Twenty two of 29 allocated participants received the intervention. STarTBack categorised n=16 (55%) participants ‘not at low risk’. Physiotherapists identified reasons for caution for 8 (36%) participants, commonly risk of overdoing activity (n= 4, 18%). There was no relationship between STarTBack and physiotherapists’ evaluation of caution. Physiotherapists identified 154 problems (mean(SD) 5.36(2.63)). Those ‘not at low risk’, and/or requiring caution presented with more problems, and required more sessions (mean(SD) 3.14(1.16)).

Conclusions

Patients present differently and therefore require tailored interventions. These differences may be identified using clinical reasoning and outcome data.

Keywords

Lumbar discectomy, physiotherapy, clinical reasoning, STarT Back

Funding statement

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Competing Interests Statement

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Article summary

Strengths and limitations of this study

- The study employed a rigorous process to analyse and evaluate an optimised 1:1 physiotherapy outpatient intervention for patients following primary lumbar discectomy
- To reflect current practice, the 9 item STaRT Back may have been more valuable to avoid reducing the tool's discriminative power
- Although specific interventions were indicated as utilised, free text sections were often left unanswered thereby limited depth of information gained, perhaps reflecting the increasing demands placed upon NHS physiotherapists
- The study conclusions are limited by the low numbers of patients but some valuable insights can now be used to develop further work

Word count

3762 words

INTRODUCTION

With a lifetime prevalence of 80%, low back pain (LBP) represents a considerable health issue [1] with extensive financial (estimated £10,668 million annually) and societal cost. [2] Surgical management is the largest single component of expenditure, with lumbar discectomy a common procedure to excise part of a prolapsed intervertebral disc for a primary indication of leg pain. [3] Data supports high numbers of patients undergoing surgery, with 8,478 operations performed within the UK National Health Service (NHS) in the 2013/2014 year; [4] and annual estimates of 12,000 in the Netherlands, [5] and 287,122 in the USA. [6] Lumbar discectomy is considered effective, with documented success of 46-75% at 6-8 weeks, and 78-95% at 1-2 years post surgery. [3]

However, evidence suggests ongoing disability for some patients, with 70% fit to return to work 12 months after surgery [7] and 30-70% experiencing residual pain. [8] Re-operation is also an issue, estimated as 3-12% patients in the Netherlands, [9] and 14% in the UK. [4] With a low mean working age of 45 years for patients undergoing surgery and short mean hospital stay of 2.3 days, [4] post-operative outpatient rehabilitation is a key issue.

Post-operative advice and rehabilitation is variable from surgeon [10] and physiotherapist perspectives. [11] In some spinal centres (44%), individual out-patient physiotherapy is provided for all patients, and in others only for patients experiencing residual problems (further 46% centres). [11] Content and advice of physiotherapy management was variable, with 1-20 sessions and a wide range of interventions advocated.

Our systematic review [12] focused on the effectiveness of physiotherapy outpatient intervention post first single level lumbar discectomy. Only 1/16 included trials was low risk of bias, and only 3

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3 trials investigated individualised physiotherapy outpatient management, reflective of current
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5 practice [11] in several countries including the UK. The others investigated group management.
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7 Evidence was inconclusive overall. Some evidence suggested physiotherapy improved disability, with
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9 a potential benefit of more intensive intervention; and weak evidence suggested improved
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11 movement/physical impairment; all in the short-term. The findings mirrored a recently updated
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13 Cochrane review that investigated effectiveness of rehabilitation programmes that included
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15 physiotherapy. [3] Only 10/22 included trials were low risk of bias. Of interest, is a potential positive
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17 effect of exercise on pain and function; with very low/low quality evidence supporting high > low
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19 intensity exercise programmes short term, and low quality evidence supporting physiotherapy
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21 commencing at 4-6 weeks compared to no treatment/education only. The evidence from their
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23 previous review [13] of n=14 trials had been stronger, with low to moderate evidence supporting
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25 effectiveness of exercise compared to no treatment, and high intensity exercises as more effective
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27 than low intensity for pain and improved physical impairment.
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33 These data raise questions regarding optimal rehabilitation. An adequately powered low risk of bias
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35 trial is required to identify whether individualised physiotherapy is effective/cost effective.
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37 Substantial heterogeneity in treatment effects across all systematic reviews could be explained by
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39 variation in quality, administration, and components of interventions, illustrated by the documented
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41 variability in management and advice. [10,11] Therefore, prior to planning a trial, an optimised 1:1
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43 physiotherapy outpatient intervention was developed through a rigorous process [14] to reflect best
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45 practice, with flexibility to tailor management to individual patients in line with MRC guidance
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47 regarding the development of complex interventions (Supplementary file S1). [15] The intervention
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49 was evaluated through an external pilot and feasibility study [16] that enabled description and
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51 analysis of the intervention and physiotherapist decision making.
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Objective

To describe, analyse and evaluate application of the optimised 1:1 physiotherapy outpatient intervention for patients following primary lumbar discectomy.

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METHODS

Design and setting

A descriptive analysis of the optimised (designed to reflect best practice) 1:1 physiotherapy outpatient intervention embedded within an external pilot and feasibility study in preparation for a RCT reported elsewhere. [16] This was a descriptive analysis of one arm of a small scale parallel RCT design, randomising consenting patients across two UK sites, the Queen Elizabeth Hospital Birmingham (QEHB) and the Salford Royal Foundation Trust (SRFT) to either the optimised intervention including patient leaflet or patient leaflet alone. The two sites delivered the same intervention (as far as could be standardised) and for this reason and owing to low numbers, there was no intention to compare between sites.

Participants

Eligibility criteria

Patients aged >18 years; post primary, single level, lumbar discectomy (including microdiscectomy), [17] and able to communicate in English. Exclusion criteria: previous surgery at same spinal level; co-morbidities that might impact on ability to participate in interventions including cauda equina compression, cognitive dysfunction, uncontrolled cardiovascular disease, [17] osteoporotic fracture, spondylolisthesis, multiple sclerosis, tumour; [18] complications from surgery; [17,19] and participation in a concurrent trial.

Recruitment

Patients at both sites were invited to participate prior to discharge. Interested and eligible patients were provided with a Participant Information Sheet, their questions answered, and asked to provide written consent to be contacted with an appointment 4 weeks post surgery. The patient leaflet was provided and discussed. At 4 weeks, written informed consent was gained from eligible patients, and patients were randomised. The patient leaflet is described elsewhere. [20]

Ethical approval

R&D approval was gained. The West Midlands – Solihull Research Ethics Committee granted ethical approval (Ref: 12/WM/0224).

Physiotherapy intervention

The 1:1 physiotherapy outpatient intervention (detailed in Supplementary file 1) encompassed education, advice, mobility exercises, core stability exercises, a progressive approach to exercise to increase intensity, and encouragement of early return to work/activity. It was designed [14] to reflect best practice, based on current evidence, [10-13] and enabled the physiotherapist to select components of the intervention that best addressed the individual patient’s problems. It was developed and agreed by the research team following consultation with clinical experts and spinal surgeons at 5 spinal centres, physiotherapists and patients; and is fully reported elsewhere [14]. This ensured an intervention informed by the evidence base that discouraged the use of treatments for which there is evidence of no effect. Although developed prior to the recently updated Cochrane review, [3] the intervention remains consistent with best evidence. Patients could attend ≤8 physiotherapy sessions ≤8 weeks, allowing patient choice and local practice variation.

The intervention commenced 4 weeks post surgery to provide optimal care. [3,12] Firstly, a list of guiding principles provided the basis for and guided the individual physiotherapist's decisions for selecting treatment content, dose and progression etc. Secondly, a table of dual purpose provided a 1] description of the intervention and 2] structure to enable physiotherapists to record the delivered intervention. In line with MRC guidance, [15] the intervention incorporated flexibility to tailor management to individual patients needs following the physiotherapist's assessment of the individual patient and identification of their problems; ensuring patient centred care based on clinical reasoning. Physiotherapy clinical reasoning is complex and many trial interventions fail to capture and describe these processes. The developed intervention was acceptable to patients and clinicians. [14,16]

Demographic data and outcome assessment

Blinded outcome assessment was 4 weeks after surgery (baseline), and following intervention at 12 weeks post baseline (primary end point). Demographic data including age, gender, duration of symptoms prior to surgery, planned or emergency surgery, presence of leg and/or back pain, analgesia, employment status, and ethnicity were collected to describe participant characteristics. The primary outcome was the Roland Morris Disability Questionnaire, and the choice of secondary measures was informed by patients, surgeons, and physiotherapists: Global Perceived Effect (1=completely recovered, 2=much improved, 3=slightly improved, 4=not changed, 5=slightly worse, 6=much worse and 7=worse than ever compared with pre-surgery), Visual Analogue Scale leg pain and back pain (0-10cm, with 0 "no pain" and 10 "worst pain ever"), EQ-5D 5L, time to return to work/normal function/full duty, Tampa Scale for Kinesiophobia (17 items, each rated as 1 "strongly disagree", 2 "disagree", 3 "agree", or, 4 "strongly agree", total score out of 68), Fear Avoidance and Beliefs Questionnaire (16 items rated 0-6 informing 2 subscales: FABQ physical activity total score

24, and FABQ work 42), Straight Leg Raise, range of lumbar movement, analgesia, and re-operation. [16] Adherence was measured. The outcomes at 4 and 12 weeks post surgery are reported in full elsewhere [14] and results were promising for both interventions.

Keele STarT Back tool

The Keele STarT Back Tool was also part of data collection at baseline. [21] It was developed for patients presenting with LBP in primary care to inform stratification of care based on identification of barriers to recovery. The tool possesses high reliability, [21] and validity compared to the Örebro Musculoskeletal Pain Screening Questionnaire. [22] Researchers have investigated the predictive value of STarT Back in secondary care, in physical therapy clinics in USA [23,24] and Danish specialist care; [25,26] finding it less effective than in primary care, but equivalent to other measures such as pain intensity or activity limitation. The 6-item tool was used for consideration of participant questionnaire burden (referred leg pain, disability, catastrophising, depression and overall impact items) that stratifies patients into low risk/not at low risk of poor outcome. It has not been validated in a post-operative population and was therefore used descriptively in this study to provide preliminary data.

Physiotherapists

Eligible treating physiotherapists were any band (grade) and working within the outpatient department. They were blinded to baseline STarT Back and outcome measure data. Training (AR/PG) standardised intervention delivery and answered questions.

Detail of intervention data collection

Physiotherapists and service users informed the development of the data collection tool that enabled capture of key components of the physiotherapy assessment to inform delivery of the intervention [14] (Supplementary file 1).

Data Analysis

Data were transferred to SPSS (version 21, IBM, New York, NY) and all data were checked to ensure their integrity. Statistical analyses included a summary of participant characteristics and pre-planned descriptive analyses. Thematic analysis was used to group related data [27] to enable descriptive analysis that explored: demographics, treatment detail and whether physiotherapists identified a need for caution (aspects of clinical reasoning), and STarT Back data; in the context of treatment duration, frequency of interventions, problems identified, number of sessions and discharge data.

FINDINGS

Participants

The study ran from January 2013 to July 2014, inclusive of recruitment, intervention, outcome assessment and focus groups. Figure 1 presents the trial CONSORT diagram. Twenty nine patients were randomly allocated to the 1:1 physiotherapy and patient leaflet intervention (n=11 QEHB, n=18 SRFT), and their characteristics are detailed in Table 1. The recruitment factor was 25/77 (32%) at the QEHB site (randomised / introduced) and 34/175 (19%) at the SRFT site; travel was the key issue for patients not interested in participating.

Table 1: Baseline participant characteristics 1:1 physiotherapy /patient leaflet intervention group

Characteristic		n*	Participants
Gender (male : female)		29	17:12
Age in years (range, mean ± SD)		29	26-64, 44.04 ±9.79
Nature of surgery (planned : emergency)		29	26:3
Ethnic group	White Caucasian	28	25
	Other white background		1
	Indian		2
Employment status	Employed	28	15 (n=1 also part time student)
	Self-employed		8
	Unemployed		2
	Retired		2
	Other (teaching contract ending)		1
Income band	<£10,000	27	2
	£10,000-19,999		7
	£20,000-29,999		7
	£30,000-39,999		4
	£40,000-49,999		1
	£50,000-59,999		3
	£60,000-69,999		0
Claims	>£70,000	29	3
	Employer sick pay		13
	Statutory sick pay		6
	Disability living allowance		1

Duration of symptoms prior to surgery (mean months \pm SD)	29	68.34 \pm 93.80
Returned to work	28	Yes 8 No 19 Not applicable 1
Duties	29	Full duties 3 Light duties 4 Not applicable 22
Full or part time working (Prior to surgery, 17 were full time, 6 part time and not applicable for 5 (missing data for 1))	29	Full time 6 Part time 2 Not applicable 21
Weeks returned to work (mean \pm SD)	28	3.81 (1.60)
Returned to normal activity (yes:no)	29	7:22
Weeks returned to normal activity (mean \pm SD)	27	3.21 (1.63)

*Some missing data

Most surgical procedures were planned and the mean age of participants reflects a working population with 83% participants working (employed/self employed). At the 4-week baseline 28% (n=8) were back at work. The mean duration of symptoms prior to surgery was 61 months. Table 2 illustrates the clinical presentation of participants. All participants presented with pain and the majority with leg pain (93%) prior to surgery. Paraesthesia and numbness were common. At baseline, participants presented overall as moderate disability and although pain was mostly of low severity at this point, most required analgesia. The median Global Perceived Effect of 2 reflected considerable improvement from the surgery, perhaps also reflected in the high health related quality of life scores. Patients presented with a high TAMPA reflecting issues of kinesiophobia.

Table 2: Clinical presentation of the individualised 1:1 physiotherapy outpatient intervention participants (baseline data)

Measure		n*	Participants
Duration of symptoms prior to surgery (mean months, ±SD)		29	68.34 ±93.80
Nature of symptoms prior to surgery n (%)	Back pain (number)	29	22 (76)
	Leg pain (number)	29	27 (93)
	Paraesthesia	29	18 (62)
	Numbness	29	21 (72)
	Weakness	29	14 (48)
	Cauda equina	29	4 (14)
Currently taking pain relief (yes:no)		28	22:6
Roland Morris Disability Questionnaire (range, mean, ±SD)		29	0 to 23, 10.52 ±5.94
Global Perceived Effect (median, interquartile range(IQR))		29	2, 1
VAS Back Pain (mean, ±SD)	Today	29	2.30 (1.80)
	Least in last 2/52	29	1.48 (1.31)
	Greatest in last 2/52	28	4.80 (3.06)
VAS Leg Pain (mean, ±SD)	Today	28	1.62 (2.13)
	Least in last 2/52	28	0.84 (1.55)
	Greatest in last 2/52	28	3.74 (2.93)
TAMPA (mean, ±SD)		29	40.48 (6.47)
FABQ physical activity (mean, ±SD)		27	13.15 (4.52)
FABQ work (mean, ±SD)		26	19.96 (11.15)
EQ5D 5L (VAS): Health today (mean ±SD)		29	71.61 (16.50)
EQ5D 5L (median (IQR) min, max)	Mobility	29	2 (1) 1,4
	Self-care	29	1 (1) 1,3
	Usual activities	29	3 (1.5) 1,5
	Pain/discomfort	29	3 (1) 1,4
	Anxiety/ depression	29	2 (1.5) 1,5
Range of movement degrees (mean, ±SD)	Flexion	29	3.54 (1.96)
	Extension	29	0.71 (3.40)
	Left side flexion	29	31.56 (17.96)
	Right side flexion	29	30.71 (17.89)
Straight leg raise test: angle of symptomatic leg (mean, ±SD)		29	66.64 (18.02)
Straight leg raise n (%)	Test positive	27	25 (86)
Straight leg raise test Limiting Factor n (%)	Pain	27	14 (48)
	Resistance	27	11 (38)
	Pain & Resistance	27	2 (7)

*Some missing data

The STarT Back data (Table 3) illustrate that n=16 (55%) participants scored ≥ 3 and would be categorised as not at low risk of chronicity/poor recovery and therefore physiotherapy would be recommended.

Table 3: Baseline STarT Back data individualised 1:1 physiotherapy outpatient intervention participants (n=29)

STarT Back item	n (%)
My back pain has spread down my leg(s) at some time in the last 2 weeks	19 (66)
I have only walked short distances because of my back pain	17 (59)
In the last 2 weeks, I have dressed more slowly than usual because of back pain	14 (48)
I feel that my back pain is terrible and it's never going to get any better	4 (14)
In general I have not enjoyed all the things I used to enjoy (number)	22 (76)
Overall, how bothersome has your back pain been in the last 2 weeks?	9 (31)
Number of participants scoring 3 or above – not at low risk of chronicity / poor outcome (criteria for referral to physiotherapy)	16 (55)
6 item STarT Back total score (median, interquartile range)	3 (2)

Of the n=29 participants allocated to the optimised intervention, n=22 received the intervention.

N=1 QEHB and n=6 SRFT did not receive the intervention (5 female, 2 male), and 5/7 were categorised not at low risk using STarT Back. No adverse events were reported and no participant required further surgery.

Treating physiotherapist assessment of n=22 participants who received the intervention

Eight participants (36%) had reasons for caution identified by the physiotherapists, the most common being at risk of overdoing activity (n= 4, 18%) through returning to work early (n=1), keen to return to heavy work/weight training (n=1), tendency to overdo exercise (n=1), and diagnosis of post-traumatic stress disorder, using training as a coping strategy (n=1). Other reasons included:

care with neural mobilisations as assessment of SLR exacerbated pain for 4 days, previous trauma and orthopaedic surgery left hip and right foot, and normal precautions. There was no relationship between STarT Back and the physiotherapist’s evaluation of caution (50% of those evaluated as requiring caution evaluated as low risk).

Physiotherapy diagnosis

Table 4 details the physiotherapy diagnoses grouped according to the nature of the diagnosis.

Table 4: Physiotherapist diagnosis

Nature of diagnosis	Specific detail from individual participants (n=22)
Broad diagnosis - mechanical low back pain	Mechanical LBP - resolving non-capsular disc lesion post surgery
	Mechanical LBP post surgery
Post-surgical diagnosis - microdiscectomy	6/52 post right sided L4/5 Microdiscectomy
	Right L4/5 Microdiscectomy
	Right L4/5 Microdiscectomy
	Left L5/S1 Microdiscectomy
	Residual LBP with slight increase pain left side post microdiscectomy
	Resolving Radicular pain post L4/5 microdiscectomy. Congenital scoliosis with rotation. Leg length discrepancy following surgery for right club foot and left hip dysplasia as child
	L5/S1 Microdiscectomy. Deconditioning post surgery
	L5/S1 microdiscectomy
	L5/S1 microdiscectomy with residual S1 weakness and decreased sensation
Post-surgical diagnosis - discectomy	Right L3 Decompression
	L4/5 discectomy, fenestration and laminectomy
	L45 discectomy
	L5-S1 Fenestration and Discectomy
	5/52 post left L5/S1 discectomy - residual stiffness
Diagnosis related to problems - presenting clinical problems	Post-op back stiffness, poor core stability
	Increased adverse neural tension into right leg, lumbar spine stiffness
	Post op stiffness 5/52 post surgery
	Post op stiffness
	Left facet tightness / stiffness
	Residual weakness right glut max and med

Participants' problems

Treating physiotherapists highlighted a total of 154 problems (mean 5.36, SD 2.63). Those categorised as STarT Back not at low risk, and those evaluated as requiring caution by physiotherapists presented with a greater number of problems. Patients with a greater number of problems required more treatment sessions (Table 5).

Table 5: Number of problems Identified by physiotherapists

		Mean no of problems	Standard deviation
All 22 participants		5.36	2.63
Male (n=15)		5.07	2.74
Female (n=7)		6.00	2.45
Age (missing data n=2)	<45 years (n=10)	5.50	2.59
	≥ 45 years (n=10)	5.40	2.55
StarT Back low risk (n=11)		4.36	2.16
STarT Back not at low risk (n=11)		6.36	2.77
Caution (n=8)		6.50	1.41
No Caution (n=14)		4.71	2.97
No of treatment sessions	1-3 sessions (n=13)	3.77	2.09
	4-6 sessions (n=9)	7.67	1.23

The identified clinical problems were detailed within the framework of the 1:1 physiotherapy intervention (Table 6). The most common problem was reduced trunk stabilisation.

Table 6: Number of participants presenting with each problem

Problem	No of participants with problem (n=22)
Reduced trunk stabilisation	20
Reduced spinal ROM	17
Inadequate knowledge to enable self management	16
Reduced conditioning / fitness	14
Reduced functional mobility	12
Pain	12
Reduced general strength	10
Reduced neural mobility	10
Reduced progress / plateau in improvement	4
Impaired recovery owing to psychological factors	2
Patient not responding to RX / deteriorating / complications	1

The treatments employed by physiotherapists to manage the identified problem are detailed in Supplementary file S2. As treatment progressed, only 1 participant was documented with a problem of not responding/condition deteriorating/experiencing complications. This participant was not initially identified as requiring caution, but did present with the highest number of problems (n=9) and STarT Back not at low risk. Reduced progress/plateau in improvement was identified as a problem for 4 patients (n=2 were STarT Back not at low risk and n=1 had a problem of impaired recovery owing to psychological factors). Only 2 participants were evaluated as having a problem of psychological factors affecting recovery.

Number of treatment sessions

The mean (SD) number of treatment sessions was 3.14 (1.16), range of 1-6 (Figure 2). No participant required the maximum of 8 sessions. Table 7 illustrates that participants classified as STarT Back not at low risk, and participants requiring caution required a greater number of treatment sessions.

Table 7: Number of treatment sessions provided by physiotherapists

		Mean no of treatment sessions	Standard deviation
All 22 participants		3.14	1.61
Male (n=15)		3.07	1.58
Female (n=7)		3.29	1.80
Age (missing data n=2)	<45 years (n=10)	3.20	1.48
	≥ 45 years (n=10)	3.20	1.81
STarT Back low risk (n=11)		2.64	1.12
STarT Back not at low risk (n=11)		3.64	1.91
Caution (n=8)		4.00	1.85
No caution (n=14)		2.64	1.28

Participants demonstrated 100% adherence at 12 weeks, although the nature of adherence did vary and was affected by factors that included their motivation. Some participants reported exercising 3 times per day and others 'as able to' around other activities such as work or gym. Participants provided reasons for reducing their exercises including: pain, increasing other activities such as golf and walking, cycling, or returning to work; but also increasing exercises, for example exercising in response to days of increased pain.

Patient outcome data

Table 8 details the patient outcome data at baseline and at 12 weeks after completion of the optimised intervention.

Table: 8: Outcome data at baseline (4 weeks post surgery) and 12 weeks (post intervention)

Outcomes		Baseline		12 weeks	
		n	Mean (SD)	n	Mean (SD)
Roland Morris Disability Questionnaire		29	10.52 (5.94)	17	5.53 (4.49)
VAS Back Pain	Today	29	2.30 (1.80)	17	2.20 (1.65)
	Least in last 2/52	29	1.48 (1.31)	17	1.70 (1.60)
	Greatest in last 2/52	28	4.80 (3.06)	17	4.34 (2.64)
VAS Leg Pain	Today	28	1.62 (2.13)	17	1.74 (2.13)
	Least in last 2/52	28	0.84 (1.55)	17	1.79 (2.50)
	Greatest in last 2/52	28	3.74 (2.93)	17	3.64 (2.82)
Tampa Scale for Kinesiophobia		29	40.48 (6.47)	17	37.35 (8.29)
Fear Avoidance and Beliefs Questionnaire physical activity		27	13.15 (4.52)	15	11.53 (7.73)
Fear Avoidance and Beliefs Questionnaire work		26	19.96 (11.15)	14	16.86 (12.48)
EQ5D 5L (VAS): Health today		29	71.61 (16.50)	17	70.06 (10.58)
Range of movement	Flexion	29	3.54 (1.96)	17	4.47 (1.49)
	Extension	29	0.71 (3.40)	17	1.64 (3.96)
	Left side flexion	29	31.56 (17.96)	15	35.59 (17.97)
	Right side flexion	29	30.71 (17.89)	15	32.49 (17.38)
Straight leg raise	Angle of symptomatic leg	29	66.64 (18.02)	17	80.53 (12.53)
		n (%)		n (%)	
Straight leg raise	Test positive	25 (86)		9 (53)	
Straight leg raise limiting factor	Pain	14 (48)		4 (24)	
	Resistance	11 (38)		9 (53)	
	Pain & Resistance	2 (7)		0 (0)	
	Missing	2 (7)		4 (24)	
		n (%)		n (%)	
Return to work	Yes	8 (28)		10 (59)	
	No	19 (56)		5 (30)	
	Not applicable	1 (3)		2 (12)	
	Full time	6 (21)		8 (47)	
	Part-time	2 (7)		2 (12)	
	Not applicable	21 (72)		7 (41)	
Type of duties on return to work	Full duties	3 (10)		7 (41)	
	Light duties	4 (14)		3 (18)	
	No or not applicable	22 (76)		7 (41)	
Return to normal activities	Yes	7 (24)		11 (65)	
	No	22 (76)		6 (35)	
		N Mean (SD)			
Return to work: weeks post-surgery mean (SD)		8	3.81 (1.60)	10	7.8 (4.71)
Return to normal activities: weeks post-surgery		7	3.21 (1.63)	11	8.18 (4.51)
		n (median, IQR)		n (median, IQR)	
Global Perceived Effect (median, range)		29 (2, 1)		16* (2, 0.75)	

Note: IQR – interquartile range, * missing data)

For the primary outcome measure the RMDQ, sensitivity to change was assessed at 12 weeks with mean (SD) change -6.18 (5.59), 95%CI -9.01 to -3.30 for the individualised 1:1 physiotherapy outpatient intervention. Full data and statistical analysis is reported elsewhere [16].

Patient discharge data

Of the treating physiotherapists who included their assessment of the patient's status at discharge (n=12), all felt that the patient had improved. The data highlights that n=3 patients required further care (Supplementary file S3).

DISCUSSION

Participants

The mean duration of symptoms prior to surgery of 68 months is substantial and illustrates the chronic nature of patients. Their clinical presentation was characteristic of disc problems affecting the nerve roots with all patients presenting with pain and the majority with leg pain (93%); most accompanied with paraesthesia and numbness. The mean age of participants of 44 years emphasises the importance of returning to work/function. The demographic profile closely resembles the populations in existing clinical trials, [3,12] and wider UK data. [4]

At 4 weeks post surgery (optimal intervention timing) [3,12] in the sub-acute stage of healing, participants were characterised by moderate disability (mean RMDQ 10.52), and although pain was of overall low severity, most still required analgesia. There was considerable variability in disability (range 0-23, SD 5.94) highlighting heterogeneity of this population. While the median GPE of 2 and high health related quality of life scores reflected considerable improvement from surgery, participants did present with high kinesiphobia. The mean TAMP of 40.48 (SD 6.47) was ≥ 37 , the recommended cut-off. [28] This may reflect a lack of confidence in returning to function following surgery. In contrast, the mean(SD) FABQ activity score of 13.15(4.52) and FABQ work of 19.96 (11.15) were not elevated according to preliminary data regarding cutoff scores. [29,30] These differences are interesting as some overlap between these two measures in a chronic LBP population is proposed, and a strong relationship exists between disability and increased FABQ. [31]

Use of STarT Back suggested that at baseline, 55% of participants required physiotherapy; being evaluated not at low risk of poor outcome. Physiotherapy evaluation designated other patients as requiring caution in their management, and others with multiple problems that were not detected

using STarT Back. Leg pain – a question on STarT Back is the main indicator for lumbar discectomy and so this may have affected the data, reflecting an obvious limitation of STarT Back in this population. Interestingly, 5/7 patients who did not attend for physiotherapy were classified as low risk of poor outcome which may have informed their decision not to attend. This is the first time the STarT Back tool has been used in secondary care with post-operative patients, as previous secondary care studies excluded post-operative patients [23] or included a broad range of conditions. [24,26] The STarT Back tool has less predictive ability in secondary care but its performance equals alternative measures. [26] Overall, STarT Back may therefore be useful in combination with other factors to inform decisions regarding patients that require more than minimal physiotherapy intervention. This merits further investigation to explore potential stratification of this population.

Physiotherapist clinical reasoning

Diagnosis and caution

Physiotherapists used a range of diagnostic categories following their assessment of patients, with most focused to the surgical procedure, distinguishing discectomy, microdiscectomy and level of procedure; reflecting a biomedical approach. The most common levels were low lumbar specifically L_{4,5}, S₁. Physiotherapists designated n=8 participants as requiring caution, the main reason being a risk of overdoing activity at a time when tissues are still healing; and this evaluation did not reflect STarT Back. This does suggest, unsurprisingly that STarT Back is not focused on all relevant issues for this population, and that the intervention framework facilitated further discrimination between patients.

Participants' problems

The mean of 5.36 (SD 2.63) problems highlighted the substantive issues still experienced by participants 4 weeks following surgery. The higher number of problems was consistent with the physiotherapist reasoning around caution and STarT Back not at low risk. The nature of the identified problems reflected the chronicity and complexity of patients undergoing surgery, and therefore the requirement of intervention to support their ability to self-manage. The nature of problems reflected a focus on function with the key issues being muscle strength, range of movement, general conditioning and fitness.

Physiotherapy treatment

Clarity of a framework for the intervention [15] perhaps contributed to a consistent approach to physiotherapy management that did not reflect previously identified variability. [11] Treatments reflected an emphasis on education, advice and progressing activity and function, with the use of manual therapy, specific exercises, and general exercise interventions. Reduced neural mobility was identified as a problem for n=10 participants but few specific treatment interventions were implemented; suggesting that neural symptoms resolved through other interventions/time. There was an emphasis on progression of management, for example, exercises for an individual, but not the emphasis on high intensity exercises within the literature; [3,12] perhaps limited by the exclusion of exercise class interventions in this study. Psychological issues were only identified for n=2 participants and so psychologically informed interventions were not widely used (cognitive behavioural approaches, pacing or goal setting). This suggests that physiotherapists were happy using education, advice and other interventions to address kinesiophobia. The number of physiotherapy sessions ranging 1-6 was not reflective of the UK survey of 1-20 sessions perhaps reflecting a change in more recent practice. [11] The physiotherapists reasoned that participants with a greater number of problems, or in situations where caution was required, needed a greater number of sessions.

Outcome data

The data demonstrate that participants improved in most outcomes by 12 weeks. In particular, the return to work data was promising with 59% participants back at work and 65% back to usual activities by 12 weeks compared to 28% and 24% at baseline. This compares to 70% fit to return to work 12 months after surgery. [7] For the RMDQ, sensitivity to change at 12 weeks was promising. These positive outcomes were reflected in the physiotherapists' discharge summaries, and physiotherapists identified that n=3 participants required further management, identifying a small number of participants who required greater intervention than the defined parameters. Although improved, an issue that requires further consideration is kinesiophobia as at 12 weeks the TAMPA remained close to the ≥ 37 cut-off. [28]

Limitations

While some potentially interesting differences between participants are highlighted and areas for further investigation identified, it is difficult to draw meaningful conclusions from this data owing to the low number of participants. To reflect current practice, the 9 item STarT Back may have been more valuable to avoid reducing the tool's discriminative power. [25] Although specific interventions were indicated as utilised, free text sections were often left unanswered thereby limited depth of information gained. It is difficult to establish whether this represents a training issue regarding data collection, or the increasing demands placed upon NHS physiotherapists. The wide inclusion of all bands of physiotherapist with some less experienced in managing this population may also have contributed to these issues.

CONCLUSIONS

These data suggest that patients present differently post lumbar discectomy and therefore require different interventions. These differences can be identified by clinical reasoning and a tool such as STarT Back, although the congruence between the two merits further consideration, and these findings merit further investigation in a larger sample. The crux of this issue is the identification and targeted treatment of patients to ensure that patients at low risk of poor outcome are not over treated and patients not at low risk of poor outcome are not under treated. This is a key issue in this climate of austerity and the move towards more resourceful healthcare, improving quality and safety, and minimising costs by avoiding unnecessary treatment. [32]

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Authors' contributions

AR and PG are Senior Lecturers in physiotherapy and NH is a lecturer in physiotherapy. MC is a Professor of outcomes methodology. AC, AH and LW are clinical specialists and extended scope practitioners working in spinal surgery. AR, PG, NH, AC, AH and LW have long-standing professional interests in the rehabilitation of patients following spinal surgery, and all have a professional focus to musculoskeletal physiotherapy. AR, PG, AH and LW were responsible for the conception of the study. AR, MC, PG and NH were responsible for the design and methodology. AR, AC and NH were responsible for the data analysis. All authors have contributed to the study and have been involved in developing the content of the article. AR and AC wrote the first draft of the paper. AR has worked with all authors reworking content into subsequent drafts. All authors gave final approval of the version to be published. AR is the guarantor.

Data sharing statement

The complete data are available from the corresponding author.

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Figure 1: CONSORT DIAGRAM (Period 14.01.13 to end of study)

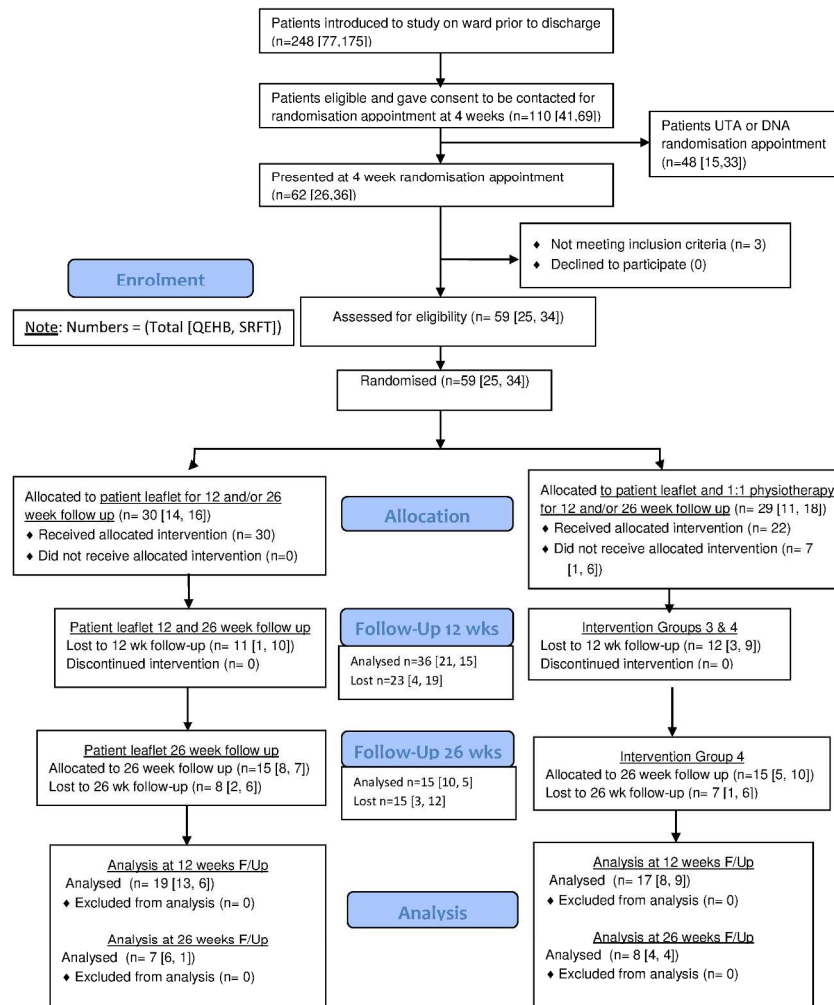


Figure 1: CONSORT DIAGRAM

215x279mm (300 x 300 DPI)

Figure 2: Number of treatment sessions

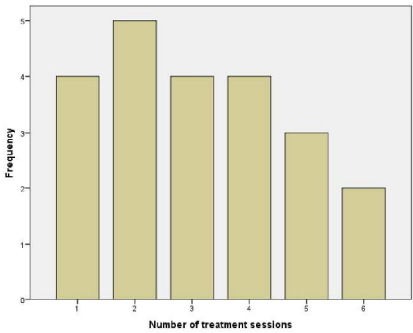


Figure 2: Number of treatment sessions

215x279mm (300 x 300 DPI)

Supplementary file S1

Physiotherapy treatment

Principles

[These principles are intended to provide the basis for and guide the individual physiotherapist's decisions for selecting treatment content, and deciding dose and progression of treatment etc].

1. To provide a framework and, thereby, some standardisation for clinical decision-making for physiotherapists.
2. To enable flexibility of the intervention for the individual patient, to ensure patient centred practice.
3. To enable treatment according to assessment findings of the individual patient, through flexibility of the intervention.
4. To commence the intervention at approximately 4 weeks post surgery, to provide optimal care.
5. To allow for patient choice and variations in practice by delivering up to 8 physiotherapy sessions for each patient, over a period of up to 8 weeks (taking the patient up to 12 weeks post surgery).
6. To decide the number of contacts required, nature of the intervention, and speed of progression based on an initial assessment (and refined by subsequent re-assessment as appropriate).
7. To apply the intervention to patients alongside use of the post lumbar discectomy manual.
8. To use individualised goal setting as a strategy to guide progression.
9. To consider high intensity exercise for patients for whom this might be slightly more effective than low intensity for pain and improved functional status. Intensive interventions include approaches to physiotherapy through exercise, behavioural rehabilitation, or a multimodal approach. High intensity can be defined in terms of repetitions, effort, difficulty etc.
10. To follow a progressive approach to exercise with encouragement of early return to work and activity (or a graded return to work for those with jobs involving higher physical demands), to be in line with optimal care.

Table detailing the proposed 1:1 intervention

Table of dual purpose – to provide 1] a description of the intervention and 2] a structure to enable physiotherapists to record the delivered intervention.

Instructions:

- Following your initial examination of the patient, please complete the first 4 sections of the table from ‘participant number’ to ‘problem list’.
- For the first session please also detail under physiotherapy session 1 your interventions.
- For subsequent visits, please detail under the relevant session number your interventions.
- At discharge please complete the final ‘discharge’ box.
- At discharge, please reinforce that further support would be via their GP.
- The table is to document what you have done NOT to guide you in way as to what you should do.
- The list of interventions covers every intervention you might want to use, not what you should use.

Participant number:			
Physiotherapy diagnosis:			
Any reasons for caution:			
Problem list:	Problem	Session problem added (1-8)	Session problem resolved (1-8)
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	9.								
	10.								
PROBLEM	Treatment intervention options <i>(under 'detail', please provide information regarding specific techniques, dosage, progression etc)</i>	Number of physiotherapy session <i>(please tick the intervention used for each physiotherapy session)</i>							
		1	2	3	4	5	6	7	8
	Please insert dates of physiotherapy sessions under the number of the session								
Reduced functional mobility	Advice to gradually increase walking distance <i>Detail:</i>								
	Advice re getting in and out of car <i>Detail:</i>								
	Walking activities <i>Detail:</i>								
	Stairs <i>Detail:</i>								
	Advice re how to manage foot drop <i>Detail:</i>								
	Other - please detail								
Reduced knowledge to enable self management	Explanation of healing, pain, recovery time, expectations of surgery <i>Detail:</i>								
	Discussion of aims and expectations of treatment <i>Detail:</i>								

	Discuss any anxieties and explore any fear avoidance issues <i>Detail:</i>								
	Goal setting <i>Detail:</i>								
	Reinforcing functional advice from manual e.g. specific advice on driving, milestones etc <i>Detail:</i>								
	Discuss increasing activity and to plan to return to work (or normal activities) as soon as able <i>Detail:</i>								
	Discuss return to work plan and encourage patient to actively consider job/requirements +/- begin discussions with employer regarding graded return <i>Detail:</i>								
	Advice on general activities/ increasing other CV exercise e.g. gym, swim, cycle etc <i>Detail:</i>								
	Advice re smoking and bone healing <i>Detail:</i>								
	Tailored lifting advice <i>Detail:</i>								
	Tailored postural advice <i>Detail:</i>								
	Other - please detail								
	Accessory movements e.g. PA technique <i>Detail:</i>								

Reduced spinal range of movement	Physiological movements / mobility exercises in weight bearing <i>Detail:</i>								
	Physiological movements in non weight bearing <i>Detail:</i>								
	Other - please detail								
Reduced trunk stabilisation	Transversus abdominis in neutral <i>Detail:</i>								
	Gluteal exercises <i>Detail:</i>								
	Progression of transversus abdominis <i>Detail:</i>								
	Non-specific core stability exercises <i>Detail:</i>								
	Multifidus retraining <i>Detail:</i>								
	Advanced trunk stabilisation <i>Detail:</i>								
	Other - please detail								
Reduced general strengthening	Lower limb strengthening exercises <i>Detail:</i>								
	Upper limb strengthening exercises <i>Detail:</i>								
	Other - please detail								

Reduced neural mobility	Specific cautious movements								
	<i>Detail:</i>								
	SLR performed actively								
	<i>Detail:</i>								
	SLR performed passively								
	<i>Detail:</i>								
	Active slump								
Reduced conditioning / fitness	<i>Detail:</i>								
	Passive slump								
	<i>Detail:</i>								
	Other - please detail								
	Graded functional exercises								
	<i>Detail:</i>								
	Paced increase in activity								
	<i>Detail:</i>								
	General aerobic exercises								
	<i>Detail:</i>								
	General strength training								
	<i>Detail:</i>								
	Low intensity exercises								
	<i>Detail:</i>								
	High intensity exercises								
	<i>Detail:</i>								
	Other - please detail								

Reduced progress / plateau in improvement	Continue with exercises independently at home <i>Detail:</i>								
	Short and longer term goal setting <i>Detail:</i>								
	Planning for the future <i>Detail:</i>								
	Other - please detail								
Pain	Explanation of pain physiology <i>Detail:</i>								
	Advice on pain relief and who to contact <i>Detail:</i>								
	Advice re when to stop taking pain killers <i>Detail:</i>								
	Advice re how to manage flare ups <i>Detail:</i>								
	Pain control interventions e.g. Acupuncture, TENS <i>Detail:</i>								
	Other - please detail								
Impaired recovery owing to psychological factors	Cognitive behavioural approach <i>Detail:</i>								
	Pacing: <i>Detail</i>								
	Goal setting: <i>Detail:</i>								
	Other – please detail								

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Patient not responding /condition deteriorating / experiencing complications	Liaise with surgical team to discuss case								
	Detail:								
	Liaison with surgical team / colleagues								
	Detail:								
	Other - please detail								

Patient discharge:

Please summarise the outcome of physiotherapy at the point of discharge and any specific advice that you have given to the patient.

Supplementary file S2

Treatment employed by the physiotherapists for the problems present in the n=22 participants

Problem (in order of treatment record)	No of participants with problem	Treatment employed by the treating physiotherapist	n	Details added by physiotherapist relating to the treatment (direct quotes)
Reduced functional mobility	12	Advice to gradually increase walking distance	12	Goal: be able to do 5 hour walk Already doing, encouraged to continue Walking 30 minutes currently; to increase as he feels able Regular short walks Speed up walking to make aerobic Advice to increase time walking and not worry about distance Progress walks from 3 per week to daily. Monitor stops during 2 mile walk Advised to slow down - build up of exercise gradually If no neurological pain as discussed in detail
		Advice re getting in and out of car	1	
		Walking activities	9	Restoration of normal walking pace to be monitored Discussion with patient - shoe raised as has altered gait due to leg length Walk regularly, especially on days when in meetings Gradually progress walking distance Regular short walks Discussed with patient - increase concentration on left foot position and foot control Treadmill Advised a day's hill walking up Scafell Pike is too much
		Stairs	2	28 stairs to flat. Does minimum 4 flights / day To aim for stairs with right leg leading
		Advice re how to manage foot drop	2	Tibialis anterior strengthening - no functional foot drop Monitor left mild foot drop
		Others	4	Encouraged use of exercise bike

				Return to gym, advice re bike, treadmill and stepper Calf strengthening Advice re gradual swimming and cycling
Reduced knowledge to enable self management	16	Explanation of healing, pain, recovery time, expectations of surgery	15	Particularly around disc dehydration and nerve root mobility Explained still healing at 6 weeks Nerve damage recovery 4 months Soft tissue healing 4-8 weeks Can start to increase activity at 6 weeks eg. side plank Need to be careful between 6-12 weeks. Neural recovery 4 months Time scales to return to heavy work and gym work discussed Nerve recovery time scale, bone healing 12 weeks Explain healing time frame and limits to safe return Discussed in session 2 as reason for increased calf ache
		Discussion of aims and expectations of treatment	15	Discussed return to normal activities Explained healing and time lines Resolve leg pain and increase functional activity Restore muscle power to full power Monitor increase in fitness and return to activity Improve lumbar extension. Improve core. Improve condition / stamina for return to work Return to activity and normal work and gym To monitor residual symptoms. Assess and manage core stability Possibility for full/partial recovery discussed with patient
		Discuss any anxieties and explore any fear avoidance issues	12	Vigilant re employing correct movement habit Patient not moving into flexion at all due to fear avoidance Work place return and activity practise to decrease anxiety Nil, patient need to be discouraged from overdoing it Mild fear of lumbar flexion Main anxiety is "will I return to golf?" Advice return re gym Post traumatic stress disorder - patient keen to return to high level activity immediately as a coping strategy Discuss fear avoidance Fear of flexion instilled by preoperative emphasis on extension

		Goal setting	7	(1) Walk 5 hours, (2) walk normal pace (3) Do housework thoroughly Independent with home exercise programme, return to gym, improve gait return to low level, high repetitions weight lifting at 8 weeks Return to work by 12 weeks Attempt to set more realistic recovery goals Return to rowing, gentle cycling. At 10-12 weeks golf / mountain biking
		Reinforcing functional advice from manual e.g. specific advice on driving, milestones etc	7	No heavy lifting 12 weeks to moderate activity. No mountain biking until 12 weeks No heavy lifting etc Advice neutral spine in function Advice on 6 week / 12 week milestones Advice on rowing position, sitting and forward lean posture
		Discuss increasing activity and to plan to return to work (or normal activities) as soon as able	13	Already returned to work Advice regarding occupational hazards No plan to return to work yet but phased return discussed Assess ability to lift weight after 6 weeks post op Discussed with patient who has already returned to work - requires increased driving and sitting Walking, lifting Plan to build activity and to assess lifting techniques approx 12 weeks Time scales and work handling discussed with patient Phased return to work Decrease activity to enable healing time, no heavy or intense training Returned to sedentary job on day 1 post surgery
		Discuss return to work plan and encourage patient to actively consider job/requirements +/- begin discussions with employer regarding graded return	7	Practise work physical tasks in physiotherapy session Discuss with employer need for breaks and regular position change Increase walking Patient to consider alternative job roles Discussed pacing
		Advice on general activities/ increasing other cardiovascular exercise e.g. gym, swim, cycle etc	15	Discussed gym - cross trainer, bike, gentle increase weights as comfortable Gentle increase in activity and light cardiovascular gym work Can freely increase aerobic work Static bike, increase walking, stair

				Advice on swimming alternate days Cross trainer, cycle and swim to start Return to controlled gym work post 12 weeks Advice to add bike to gym Advice on gentle cardiovascular exercises
		Advice re smoking and bone healing	0	
		Tailored lifting advice	6	Lifting posture and technique with a work place hoist Lifting heavy blocks on return to work
		Tailored postural advice	10	Sitting - forward / backward lean Sitting hip, sit to stand Maintaining stable thorax / pelvis relationship through movements Maintaining neutral spine / pelvis during sit to stand etc Sitting, sit to stand Talked through neutral spine Flat back posture Given ergonomic advice sheet, pacing, regular breaks Sitting posture, forward lean sitting from hip, arm reach, head position
		Others	2	Advice re gentle scar massage Advice re anti-inflammatories as prescribed, and activity modification
Reduced spinal range of movement	17	Accessory movements e.g. posterior-anterior (PA) technique	10	Grade III PA mobilisations central and unilateral x 3 x 30 seconds PA grade III x 30 seconds PA grade III L3-5 Grade IV PA mobilisations central and unilateral right L3-5 PA L1-3 grade III, PA in extension L1-3 grade III Mobilised right L4,5,S1 to decrease pain on hip extension PA L2 to improve extension but minimal benefit. Better at 2nd session. Grade III x 3 x 30 sec Central PA L4/5 grade III, PA grade III left side L4/5 x 1 min, L4 right and left, L3 right and left, combined left side flexion PA L4-5 PA left side grade III L1,2,3,4 facet x 1 minute each
		Physiological movements / mobility exercises in weight bearing	8	Stretches in standing Lumbar spine stretches in standing Seated and standing range of movement Gentle weight bearing range of movement

		Physiological movements in non weight bearing	8	Lumbar spine active range of movement stretches in crook lying Reviewed current exercises Seated range of movement Lumbar extension To assess lumbar spine vertebral movement Active range of movement exercises
		Others	2	Soft tissue techniques and trigger point pressure to left quadratus lumborum Palpation and sacral mobilisation to assess neural interface and re-test SLR
		Transversus abdominis in neutral	17	Pelvic Tilt Pelvic Tilt Concept gained via explanation of mechanism and pelvic tilt Corrected technique Trans Abdominus setting in crook lying - very poor Supine crook transverses abdominus, pilates 100s exercise Pelvic Tilt Pilates 100 setting Crook lying Transversus abdominus neutral
Reduced trunk stabilisation	20	Gluteal exercises	12	Concept gained via explanation of mechanism and pelvic tilt Reviewed current bridging technique Hip extension in prone knee bend Clam and bridge Prone kneeling right hip extension Bridging Piriformis release and patient taught self massage Piriformis stretch and endurance
		Progression of transversus abdominis	11	To do whilst walking at gym. Pilates exercises second treatment. 100s level 1 Decreased control on right leg crook needs addressing prior to lifting 100s and transverses abdominus sitting Bridge - ball. Single leg bridge With leg slides

				Flexion biased Position well maintained, therefore core approach not planned
		Non-specific core stability exercises	9	Sitting forward / backward, stand from wall Bridging In standing, forward and backward lean sitting Bridging and review of patients own exercises Core contraction in standing and gym ball as finds crook lying difficult Bridging and global core exercises Excellent balance on perturbation
		Multifidus retraining	1	Squat work
		Advanced trunk stabilisation	4	Bridge to 1/2 range: overuses spinal extensors beyond this Advice on gym ball and gym work Right side plank with left hip abduction Bridging and increased gluteal control. Higher end core work
		Others	4	Trunk stabilisation in sitting, standing, sitting to standing and lifting Correction of spinal curve in side lying Advise on return to gym Importance of core re prevent recurrence
Reduced general strengthening	10	Lower limb strengthening exercises	9	Resisted plantar flexion with green theraband x 15 reps per day increase / decrease as able. Toe raises second treatment session Calf raise and tibialis anterior strengthening Right gluteal strengthening Sit to stand with left foot forward Stair climbing. Static bike Squats Ankle dorsi flexion active assisted range of movement and strength Isometric calf holds. Calf raises appointment no 2 Gluteal exercises Exercise bike, rower
		Upper limb strengthening exercises	1	Advice re lifting weights in gym
		Others	1	Treatment 2 - did not commence side plank as patient reported mild right leg symptom post exercise. Encouraged hamstring stretch
	10	Specific cautious movements		SLR exacerbated pain for 4/7 at 1st assessment

Reduced neural mobility		SLR performed actively	4	Using hamstring stretch in supine progressing popliteal angle SLR stretch with dorsi / plantar flexion x30 sec x 3 per day - not into painful range
		SLR performed passively	3	SLR mobilisations For assessment mild adverse neural tension right leg Decreased SLR due to neural tension
		Active slump	5	Sitting, left knee extension and dorsi flexion. Replace leg swing with this For adverse neural tension and hamstring length For mild adverse neural tension Use as a treatment to increase neural mobility Pelvic tilts to exercise lower lumbar spine range of movement
		Passive slump	1	With SLR for adverse neural tension
		Others	3	Sitting, leg swing, increasing reps and frequency if not exacerbating pain Heel and leg slides for gentle decrease adverse neural tension Piriformis release and stretches. Passive range of movement and SLR
Reduced conditioning / fitness	14	Graded functional exercises	8	Walking Advice on return to gym and cycling Discussed with patient staged return to sport and golf Bike and cross trainer 10% increase distance per week Advised to decrease activity to pace and manage pain and healing Cycling - start at 3/52
		Paced increase in activity	5	Walking, housework Increase gym activity gradually Walking 3rd session boom/bust activity Session 2 - to start rowing action, progressing exercises accordingly
		General aerobic exercises	8	Encouraged continue with cross trainer and bike in gym, increase gradually Advised to use cardiovascular exercise in gym - treadmill and static bike At treatment 1 already exercising aerobically 2 hours / day Walking, stairs and static bike Discussed with patient gym work Advice on static bike cycling for cardiovascular and neural mobility Exercise bike and stepper Rowing, cycling

		General strength training	2	Continue with gentle upper limb and lower limb weights in gym Discussed with patient gym work
		Low intensity exercises	0	
		High intensity exercises	1	Treatment 2 Encouraged continue with present programme for further week
		Others	3	Weight lifting starting low level Muscle energy technique hamstrings, discussed nature of osteoarthritis Muscle energy technique hamstrings
Reduced progress / plateau in improvement	4	Continue with exercises independently at home	2	Home exercise programme from hospital. Was performing bridge incorrectly
		Short and longer term goal setting	2	Improved strength and condition return to work Increase walking
		Planning for the future	1	Pilates
		Others	0	
Pain	12	Explanation of pain physiology	5	Explanation of referred pain
		Advice on pain relief and who to contact	4	General Practitioner review and neuropathic pain agents discussed with patient Discussed with GP re wean from Gabapentin
		Advice re when to stop taking pain killers	3	On paracetamol only
		Advice re how to manage flare ups	0	
		Pain control interventions e.g. Acupuncture, TENS	1	Piriformis release and acupuncture
		Others	3	Advice that intermittent pain nothing to worry about and pain is soft tissue healing Advice sensory stimulus to decreased ankle area Advice regarding preventing recurrence
Impaired recovery owing to psychological factors	2	Cognitive behavioural approach	0	
		Pacing	2	Advice pacing in gym
		Goal setting	1	Little and often rather than boom and bust
		Others	0	

Patient not responding / condition deteriorating / experiencing complications	1	Liaise with surgical team to discuss case	0	
		Liaison with surgical team / colleagues	0	
		Others	1	Liaise with consultant re return to work

Supplementary file S3

Physiotherapist’s (n=12) summary of patient outcome and advice provided at discharge

	Physiotherapist’s summary
Improved to continue with self management (n=8)	Commenced specific core exercises at treatment 3. Patient already practising bridging but was thrusting using spinal extensors and not performing movement correctly. This is a very common fault when bridging is not taught or monitored. 01/05/13 patient reports return to all normal activities - long walks, playing with grandchildren. Continues with neural mobilisation as minor residual tension present on right (SLR 70/70). Reports that she still relies on husband to carry shopping upstairs. Improvement from 32 to 16 on Oswestry.
	This patient reports a large improvement in symptoms - this was the case in the first assessment. She had followed all advice, had a good understanding of the healing process. She initially presented with numbness L5/S1 and intermittent calf pain and mild LBP, this had improved by her follow up appointment. She was happy to continue with her exercises and progress her activity at the gym independently.
	Treatment 2 - infected scar identified. Treatment 3 - scar normal appearance after receiving treatment. Undergoing investigations for bronchiectasis. Core issues identified and need to continue strengthening right gluteals / abdominals in right single leg stride prior to addressing side plank issue on right. This delayed progressing gym activities including weight resisted exercises. Treatment 4 - complaining of minor (1/10) ache right side scar and minor restriction right hamstrings. Otherwise has made excellent progress with normal restoration of function and progressing exercise tolerance to a high level.
	Patient has returned to work on full duties. Patient is driving with no problems. Resolved adverse neural tension, no measurable right leg weakness. Patient does complain of mild tenderness at times over scar. Patient independent with basic core exercise programme and has been advised on a graded return to her previous exercise level. Patient advised to avoid heavy lifting and mountain biking until 12/52 post op. Good functional range of movement and power. Patient can independently return to cardiovascular fitness and is happy to do this independently. Patient required advice on activity progression to ensure she did not progress too quickly and risk tissue healing.
	Reasonable outcome post surgery. Significant improvement. Discharged with self management advice / education.
	Patient was independent with his exercises and keen to increase his strengthening work. Lumbar spine mobility had improved but he did have a residual weakness in the left lower limb with dorsiflexion and great toe extension. This was not enough to justify use of a foot drop splint = 4/5. His long standing postural issues were ongoing. Pain had resolved and was not an issue. Patient had an extended scope practitioner review booked and would look to be re-referred to physiotherapy at this stage if required.

	<p>This patient has returned to high level gym exercise 4-5 x a week but not yet returned to work as it involves very heavy lifting and wants to discuss with consultant. I have given all the relevant advice.</p> <p>On 3rd session patient reported that only symptom was an awareness of mild tension left calf. No neurological signs. He has resumed all usual activities including cycling and rowing. Failed to attend last appointment and did not respond to my message to make contact. No concerns - therefore discharged.</p>
Required further care (n=3)	<p>Patient returned to independent gym activity. Patient has decreased leg pain post op but some increased lumbar spine pain. Patient has congenital postural issues which have not been addressed with this episode of care. Patient would benefit from further strengthening and a podiatry referral for leg length discrepancy. Advised to seek via General Practitioner. Patient independent with spinal home exercise programme and has returned to previous level of activity with good reduction of pain.</p> <p>14/08/13 patient reports 1 episode of frank incontinence, similar but more severe than the frequent but inconsistent episodes of mild incontinence pre-op. Letter to consultant recommending urodynamic testing after discussion with Clinical Specialist. 20/08/13 minor right sided LBP. Lumbar range of movement restored. Remains de-conditioned with decreased core control and would benefit from further encouragement to pursue daily exercise. Not yet back at work - fearful that work pressure might prevent phased return (nurse).</p> <p>Patient reports pain decreased from 8/10 to 4/10. Patient has residual S1 weakness and reduced sensation. Patient has a tendency to push too hard and set unrealistic goals, partly due to coping strategy of exercise with post traumatic stress disorder. Patient regularly hill walking over 12 miles. He remains with neural tension, but is managing well. When he fatigues he complains of increased S1 weakness. He is to be referred to his local physiotherapist for ongoing management and progression.</p>
Did not attend (n=1)	<p>Patient unfortunately unable to attend several appointments and then did not attend. Tried to contact to follow up but no contact. Patient therefore discharged. Patient contacted department 19/09/13 and was informed to contact GP for re-referral.</p>