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ORIGINAL ARTICLE

A clinical prediction rule for classifying patients with low back pain who demonstrate short-term improvement with mechanical lumbar traction

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Abstract The objective of the study was to develop a clinical prediction rule for identifying patients with low back pain, who improved with mechanical lumbar traction. A prospective, cohort study was conducted in a physiotherapy clinic at a local hospital. Patients with low back pain, referred to physiotherapy were included in the study. The intervention was a standardized mechanical lumbar traction program, which comprised three sessions provided within 9 days. Patient demographic information, standard physical examination, numeric pain scale, fear-avoidance beliefs questionnaire and Oswestry low back pain disability index (pre- and post-intervention) were recorded. A total of 129 patients participated in the study and 25 had positive response to the mechanical lumbar traction. A clinical prediction rule with four variables (non-involvement of manual work, low level fear-avoidance beliefs, no neurological deficit and age above 30 years) was identified. The presence of all four variables (positive likelihood ratio = 9.36) increased the probability of response rate with mechanical lumbar traction from 19.4 to 69.2%. It appears that patients with low back pain who were likely to respond to mechanical lumbar traction may be identified.

Keywords Low back pain · Lumbar traction · Clinical prediction rules

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Introduction

Low back pain (LBP) is a common cause of disability and work loss in developed countries, creating a large social and economic burden on society [7]. Between 70 and 80% of adults are affected at some time during their lives [2]. There are numerous clinical guidelines on LBP produced worldwide, yet lack of consensus about effectiveness [23, 36]. Physiotherapy (PT) interventions for the management of LBP are wide and variable, but the efficacy of many is still questionable [17].

Mechanical lumbar traction is one of abovementioned PT interventions. There is ongoing confusion surrounding the use of traction in the management LBP, with differences between recommendations in the UK, New Zealand, Demark and the USA clinical guidelines [35]. This is further confounded by a recent Cochrane systematic review which concluded that 'traction probably is not effective,' however, the authors also noted that 'we lack strong, consistent evidence regarding the use of traction due to the lack of high quality studies, the heterogeneity of study populations, and lack of power'[3]. More importantly, there was no study concerning the pre-treatment fear-avoidance status of subjects, which is increasingly considered as essential factor in musculoskeletal rehabilitation. The literature review based on few current available studies suggests that traction was most likely to benefit patients with acute (less than 6 weeks' duration) and radicular pain with concomitant neurological deficit [24], and absence of centralization with movement testing [8]. However, the above statement carries rather weak research power. Thus, the subgroup of patients most likely to benefit has not been specifically studied yet [24].

As increasingly raised awareness of classification for LBP patients to have better clinical management outcome, there are some prediction rules established by various authors, e.g. lumbar spine manipulation clinical prediction rule [6], lumbar stabilization exercise clinical prediction rule [18]. Those clinical prediction rules (CPR) contribute significantly to the establishment of classification approach to physiotherapy management of LBP.

However, to our best knowledge, there is few specific clinical prediction rules study to classify the particular group of LBP patients who respond to mechanical lumbar traction. Although some authors [8] generated prediction rules for prone lumbar traction approach, most common used supine approach is still lacked of such prediction rules. The efficiency of clinical decision-making for utilizing mechanical lumbar traction to treat LBP condition and the quality of methodology for future RCT will require more information from clinical prediction rule studies. Therefore, the purpose of our study was to identify the prediction factors for patients with LBP who demonstrate short-term improvement with mechanical lumbar traction.

Methods

Subjects

The 129 participants in this study were referred from the orthopedic outpatient clinic in the local hospital over 6 months. All participants were enlisted, when they were on the waiting list to see a physiotherapist. All participants were with a diagnosis related to the lumbosacral spine, and had a chief complaint of pain and/or numbness in the lumbar spine, buttock, and/or lower extremity. All subjects gave written consent allowing the release of test results for research purposes, as approved by a local hospital bioethics committee. Exclusion criteria were current pregnancy, signs with spinal cord injury, prior lumbar spine surgery, history of osteoporosis or spinal fracture. Subjects were not included in the data analysis if the clinician determined the subject's symptoms were likely of non-spinal origin.

Therapists

Four physiotherapists working in rehabilitation department of local hospital participated. A 2 h pre-study briefing was given, regarding study measures, introduction, intervention and ethics issues.

Measures

Basic demographic information was collected before intervention, including gender, age, height, weight, BMI (calculated), education levels (primary, intermediary, graduate), smoking situation (smoker, non-smoker), onset duration (weeks), cause of pain (trauma, gradual, sudden), past history of episode (yes/no), increase frequency episode (yes/no), pain below knee (yes/no), job status: manual (yes/no), retiree (yes/no), pain medication (yes/no), aggravating factors (sitting, standing, walking), and releasing factors (sitting, standing, walking).

Disability related to LBP was measured by modified Oswestry low back disability questionnaire (MODQ) [20]. All participants were asked to complete MODQ before intervention and after 3 traction sessions completed in 9 days. The improvement of the score more than 50% than pre-treatment was used as a determinant for a responder of mechanical lumbar traction.

Each participant completed the fear-avoidance beliefs questionnaire (FABQ) [37] before intervention to assess the beliefs about the influence of activity on LBP [37]. The FABQ contains two subscales, one is related to general physical activity (FABQPA) and the other to work (FABQW) [37].

Pain intensity was measured by numerical pain scale, (0–10, 0 indicates no pain, 10 indicates maximum pain). All participants completed the numerical pain scale by indicating average pain level during pass 1 week before intervention.

Physical examination (PE) was done by four physiotherapists. The active lumbar flexion in standing was recorded as mid-thigh, patellar, mid-shin and distal shin. The bilateral straight-leg-raise (SLR) was measured by limitation of pain. The pain with SLR (kappa = 0.83) has acceptable reliability [25]. Posteroanterior spring testing [26] was performed for mobility at each lumbar level. Mobility was judged as normal, hypermobile, or hypomobile. Neurological screening was conducted on reflex and manual muscle testing (MMT). Patellar tendon and Achilles tendon reflex were rated as normal, hypertonic, or hypotonic. MMT (i.e. iliopsoas, quadriceps femoris, hamstring, peroneal, extensor hallucis longus, gastrocnemius, and tibialis anterior) were rated from grade 1 to 5 by therapists. The test results were dichotomized into grade 5 or above as normal, grade 4 or below as weakness. The agreement (kappa) between 2 orthopaedic surgeons in 50 patients with LBP was 0.65–1.00 for MMT, 0.23–0.39 for reflex [29]. Patients were then dichotomized into neurological deficit involvement (yes/no) according to the screening findings.

Intervention

A total of three lumbar traction sessions were given within 9 days using motorized mechanical lumbar traction (Triton DTS® Traction System, The Chattanooga Group) in Fowler's position (The patient is in supine with hip and knee

90° flexion. The patient's leg is supported by a stool with adjustable height) for patients were not flexion sensitive. Patients who were flexion sensitive were given traction in the supine position. The limited number of sessions given to patients is due to ethical reason of not halting patients from receiving best treatment. Traction force was determined by 30–40% of subject's body weight. Treatment duration is 15 min with 30 s on and 10 s off intermittent approach. For those subjects who could not tolerate the regime above, the traction force was reduced according to his/her tolerance. We also gave advice to all patients to stay active during the study period.

Data analysis

Univariate analyses (using chi-square tests and individual *t* tests) were conducted to determine which variables had a significant relationship with the responsiveness of mechanical lumbar traction. We performed this analysis to determine which variables would be entered into a subsequent binary logistic regression model. Chi-square analysis was done to determine which of the binary variables were predictive of detecting a responder of mechanical lumbar traction. Binary variables included gender, education levels (primary, intermediary, graduate), smoking situation (smoker, non-smoker), cause of pain (trauma, gradual, sudden), past history of episode (yes/no), increase frequency episode (yes/no), pain below knee (yes/no), job status: manual (yes/no), retiree (yes/no), pain medication (yes/no), aggravating factors (sitting, standing, walking), and releasing factors (sitting, standing, walking), neurological deficit involvement (yes/no), spine mobility: hypomobility (yes/no) and lumbar spine flexion range (mid-thigh, patellar, mid-shin and distal shin).

Continuous variables were analyzed for their relationship with the responders of mechanical lumbar traction using independent *t* tests. Continuous variables included age, height, weight, BMI (calculated), onset duration (weeks), straight leg raise angle, pre-intervention pain (measured by numerical pain scale), pre-intervention MODQ and FABQ score.

The alpha level for all univariate analyses was set at 0.10; we chose a more liberal significance level to avoid excluding potential predictive variables. For continuous variables with a significant univariate association, sensitivity and specificity values were calculated for all possible cut-off points and then plotted as a receiver operator characteristic (ROC) curve. The point on the curve nearest the upper left-hand corner represents the value with the best diagnostic accuracy, and this point was selected as the cut-off defining a positive test.

Potential prediction variables were entered into a forward stepwise logistic regression equation to determine the most parsimonious set of variables. A significance of 0.05 was required to enter a variable into the model and a significance of 0.10 was required to remove it. The goodness-of-fit of the final regression model was tested with the Hosmer–Lemeshow statistic [19]. The proportion of variance explained by the final model was determined using the Nagelkerke R statistic [32]. Variables retained in the regression model were used to develop a multivariate clinical prediction rule for classifying subjects as likely to benefit from mechanical lumbar traction. Predictive statistics were calculated for each level of the clinical prediction rule.

The SPSS software version 13.0 for Windows (SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606-6307) was used for data analysis.

Result

The descriptive statistics data of the 129 subjects are listed in Table 1. According to the criteria of responders, there were 25 patients (19.4%) shown in this category, and 104 (80.6%) were nonresponders.

The univariate analysis of all variables provided 13 potential predicting factors (Table 1), including age (years) ($P = 0.007$), BMI ($P = 0.080$), mode of onset: traumatic (yes/no) ($P = 0.064$), prior history of LBP (yes/no) ($P = 0.041$), pain below knee (yes/no) ($P = 0.069$), job status: manual work (yes/no) ($P < 0.001$), deskbound work (yes/no) ($P = 0.002$), retiree (yes/no) ($P = 0.036$), standing ranked as worse position (yes/no) ($P = 0.057$), sitting ranked as best position (yes/no) ($P = 0.039$), right straight leg raise ($P = 0.06$), neurological deficit involvement (yes/no) ($P = 0.007$) and FABQW subscale sore ($P < 0.001$). The sensitivity, specificity and positive likelihood ratio of each individual variable associated with responsiveness calculated with 95% CI (Table 2). The cut-off points were found from ROC curve for age = 30.5, BMI = 22.3, right SLR = 67.5 and FABQW = 20.5. According to the above cut-off points, these four variables were dichotomized into positive or negative test results, before being entered into logistic regression analysis. The positive test results were age >30, right SLR >67.50, BMI <22.3 and FABQW <21.

The potential predicting factors identified from the univariate analysis were entered into the forward stepwise logistic regression analysis. There were four variables retained in the final model (Table 3): FABQW score less than 21, no neurological deficit involvement, age older than 30, and non-involvement of manual work (model $\chi^2 = 34.19$, $df = 4$, $P < 0.000$, Nagelkerke R^2 value = 0.372). These four variables were used to form the clinical prediction rule. The final model fit the data (Hosmer–lemeshow $\chi^2 = 7.79$, $P = 0.35$).

Table 1 Comparison of patients' demographic data, pain, physical examination, disability and fear-avoidance beliefs between the non-responder and responder groups

Variable	All subjects ($N = 129$)	Non-responder ($N = 104$)	Responder ($N = 25$)	P value
Female gender (%)	16.3	15.4	20.0	0.58
Age (year)	30.9 (±12)	29.2 (±10.2)	38.0 (±14.3)	0.007*
Weight (kg)	69.5 (±13.1)	70.3 (±13.3)	65.7 (11.7)	0.113
Height (m)	171.1 (±6.9)	171.2 (±7.0)	171.0 (±6.7)	0.921
Body mass index (kg/m^2)	23.7 (±3.9)	24.0 (±4.0)	22.4 (±3.5)	0.080*
Smoking status (%)				
Smoker	24.8	23.1	32.0	0.354
Education level (%)				
High	47.3	40	60	0.183
Intermediate and below	50.4	60	40	0.284
Duration (weeks)	39.7 (±82.4)	39.3 (±77.6)	41.4 (±101.9)	0.908
Mode of onset				
Gradual	45.7	44.2	52	0.484
Sudden	38.0	36.5	44	0.490
Traumatic	16.3	19.2	4	0.064*
Pain below knee (%)	35.7	39.4	20.0	0.069*
Prior history of LBP (%)	69.0	73.1	52	0.041*
Episodes of LBP becoming frequent	34.1	35.6	28	0.473
Employment (%)				
Manual work	56.6	66.4	24	<0.001*
Deskbound work	40.3	34.6	68.0	0.002*
Retiree	2.3	0.10	8.0	0.036*
Use of Pain medication (%)	50.4	52.9	40.0	0.247
Sitting ranked as worse position (%)	34.9	32.7	44.0	0.287
Standing ranked as worse position(%)	36.4	40.4	20.0	0.057*
Walking ranked as worse position(%)	23.3	23.1	24.0	0.922
All positions aggravate pain (%)	5.4	3.8	12.0	0.106
Sitting ranked as best position (%)	38.0	42.3	20.0	0.039*
Standing ranked as best position (%)	17.1	16.3	20.0	0.663
Walking ranked as best position (%)	20.2	19.2	24.0	0.594
No position relieves pain (%)	24.8	22.1	36.0	0.149
Lumbar flexion (%)				
Thigh level	6.2	5.8	8.0	0.678
Patella level	18.6	20.2	12.0	0.345
Mid-shin level	36.4	34.6	44.0	0.381
Distal shin level	38.8	39.4	36.0	0.752
Left straight leg raise (°)	64.9 (±19.1)	63.6 (±20.0)	70.4 (±14.5)	0.109
Right straight leg raise (°)	66.8 (±18.5)	65.3 (±19.0)	73.0 (±14.8)	0.060*
Absolute difference in straight leg raise (°)	7.3 (±10.4)	7.8 (±10.2)	5.0 (±11.2)	0.232
Symptom centralization (%)				
Lumbar flexion	57.4	57.7	56.0	0.878
Lumbar extension	24.0	23.1	28.0	0.605
None	18.6	19.2	16.0	0.709
Hypomobility at one or more lumbar levels with spring testing (%)	63.6	62.5	68.0	0.608
Pain at one or more lumbar levels with spring testing (%)	86.8	87.5	84.0	0.642
Neurological deficit involvement (%)	24.8	29.8	4.0	0.007*
Pain intensity (numeric rating scale)	5.7 (±1.7)	5.8 (±1.6)	5.3 (±2.0)	0.217

Table 1 continued

Variable	All subjects ($N = 129$)	Non-responder ($N = 104$)	Responder ($N = 25$)	P value
Fear avoidance belief questionnaire				
Work subscale	21.7 (±10.0)	23.2 (±9.9)	15.4 (±7.9)	<0.001*
Physical activity subscale	18.0 (4.8)	18.3 (±4.8)	16.9 (±4.7)	0.210
Modified Oswestry disability index	30.3 (±12.3)	30.6 (±11.8)	29.1 (±14.3)	0.217

* Those variables passed the first-pass test at P value set at <0.1

Table 2 Accuracy statistics (with 95% confidence interval) for individual variables for predicting success

Variable associate with success	Sensitivity 95% CI	Specificity 95% CI	Positive likelihood ratio 95% CI
Age (cut-off point ≥31)	0.64 (0.43–0.81)	0.68 (0.58–0.77)	2.02 (1.34–3.03)
BMI (cut-off point ≤22.3)	0.48 (0.28–0.68)	0.62 (0.51–0.71)	1.25 (0.78–2.01)
Mode of onset: traumatic (Y/N)	0.05 (0.003–0.26)	0.78 (0.69–0.85)	0.21 (0.03–1.50)
Prior history of LBP (Y/N)	0.85 (0.76–0.92)	0.30 (0.17–0.47)	1.22 (0.98–1.52)
Pain below the knee (Y/N)	0.20 (0.08–0.41)	0.61 (0.50–0.70)	0.51 (0.22–1.15)
Manual work (Y/N)	0.92 (0.82–0.97)	0.34 (0.22–0.48)	1.39 (1.14–1.70)
Retiree (Y/N)	0.33 (0.02–0.87)	0.18 (0.12–0.26)	0.41 (0.08–2.02)
Standing ranked as worse position (Y/N)	0.89 (0.76–0.96)	0.24 (0.16–0.35)	1.18 (1.01–1.38)
Sitting ranked as best position (Y/N)	0.90 (0.77–0.96)	0.25 (0.16–0.36)	1.20 (1.02–1.41)
Right straight leg raise (≥67.5°)	0.72 (0.50–0.87)	0.44 (0.35–0.54)	1.29 (0.96–1.74)
Neurological deficit involvement (Y/N)	0.97 (0.82–1.00)	0.19 (0.13–0.27)	1.29 (1.13–1.47)
FABQ-work subscale (≤21)	0.72 (0.50–0.87)	0.63 (0.53–0.73)	1.97 (1.39–2.80)

Table 3 Predictors for the responder to mechanical lumbar traction (forward stepwise logistic regression)

Predictor	Coefficient	Odds ratio	95% Confidence interval	P value
FABQW score less than 21,	1.12	3.07	1.05–9.01	0.041
No neurological deficit involvement,	2.55	12.75	1.50–108.0	0.020
Age older than 30,	1.43	4.18	1.48–11.76	0.007
Non-manual work job status	1.30	3.66	1.22–11.0	0.020

Nine of 25 subjects responded to lumbar traction had all four predictors presented, 19 had 3 or more predictors presented, 24 had 2 or more predictors presented, 25 had 1 or more predictors presented (Table 4).

According to the pre-prediction probability obtained from those patients who were classified as responders to mechanical lumbar traction in the study (19.4%), the positive likelihood ratio (PLR) and the post-prediction probability were calculated for each level of the prediction model [13]. The accuracy statistics including sensitivity, specificity, PLR and post-probability of successful mechanical lumbar traction for each level of the model are listed in Table 5. The best rule for predicting response to mechanical lumbar traction, based on the PLR, was the presence of all 4 variables (PLR 9.36, CI 95% 3.13–28.00).

Discussion

The purpose of our study was to identify LBP patients who would demonstrate a short-term improvement to mechanical traction approach. In order to distinguish the responders from the non-responder, MODQ was used as an outcome measure. Specially, the responders were operationally defined as individuals who showed 50% (or greater) improvement in MODQ score from baseline at post intervention. The MODQ is commonly used in research and clinical practice [6, 9, 12] for the following reasons: (1) its measurements have high test-retest reliability (ICC = 0.90); (2) it possesses good construct validity, with correlations with global patient ratings and other region-specific disability measures over 0.80; and (3)

Table 4 Number of subjects in the success and nonsuccess groups at each level of the clinical prediction rule

No. of predictor variables present	No. of subjects in the mechanical lumbar traction success group	No. of subjects in the mechanical lumbar traction nonsuccess group
4	9	4
3	19	26
2	24	56
1	25	95
0	0	9

it has good responsiveness, with an effect size of 1.8 in patients receiving physical therapy interventions for low back pain [5, 33].

The reason we decided to use 50% improvement as the cut-off point was based on the characteristics of mechanical lumbar traction as an adjunctive treatment in current clinical practice with best evidence to date [8]. Further more, our criterion was also consistent with that adopted in a previous study [6] in which a more 'dramatic' intervention such as lumbar spine manipulation was examined.

Our study identified four possible predictors namely, FABQW score less than 21, absence of neurological deficit, age above 30, and non-involvement in manual work.

The absence of neurological deficit involvement predicted 12.75 (OR) times (1.50–108.0, 95%CI) more likely benefit from the traction approach, comparing to those patient had neurological deficit involvement. This finding agrees to the current literature review result [28, 38]. The randomized control trial with relatively acceptable method score [38], included subjects with neurological deficit involvement did not support to use mechanical lumbar traction for LBP management. There is no randomized control trial has acceptable method score with exclusive criteria of subjects having neurological deficit. Only one study with minimal method score supported the use of mechanical lumbar traction for management of LBP patients without neurological deficits [28]. Yet, majority of literatures published in peer review journals did not specify the detail of the neurological deficit and radicular leg pain in their inclusive criteria. Therefore, we suggest that neurological deficit as one possible predictive factor should be carefully assessed and identified as an important subject recruitment criteria while planning randomized control trial. Low FABQ-W score (≤21) predicted 3.07 (OR) times (1.05–9.01 95%CI) more benefit from the traction approach than those patients had high fear-avoidance to work (FABQW >21). It is not surprising considering that fear-motivated behaviour has the potential to adversely impact treatment outcomes for patients with musculoskeletal pain [12]. The FABQW subscale has been previously correlated with work loss and disability in patients with chronic and acute LBP [10, 22, 37]. In our study FABQW cut-off point is 21, 2 points higher than previously reported in lumbar spine manipulation prediction study [6]. The difference may be associated with the chronicity of LBP. The condition remaines unchanged for significantly long periods [15] may affect fear-avoidance beliefs. Our study result suggest that patients with high levels of fear-avoidance beliefs about work likely require an alternative treatment approach [4]. The non-involvement of manual work identified as a predictor, which predicted 3.66 (OR) (1.22–10.95 95% CI) times more likely respond to the traction approach, than those have manual work job. Our study finding agrees to previous review [27, 34] suggestions that manual work influences low back pain possibly by muscle fatigue, spine loading and cumulative trauma. The management concern for those patients having manual work job status should be more comprehensive, regarding their job status and working environment. The age above 30 years predicted 4.18 (OR) (1.48–11.76 95% CI) times more likely to be a responder than those younger than 30 years old. This finding may be supported by the aging morphological changes to spine, structure [31] and related effect on response to mechanical loading [11, 39]. However, there are still unknown aging related effects may affect outcome of rehabilitation. However, the current study power and design is not able to explain why this particular subgroup of LBP patients who satisfied the four predictors responded to mechanical lumbar traction. We need more basic biomechanical science studies done to answer such question.

The usefulness of a CPR in identifying a patient who would respond to mechanical lumbar traction is best represented by the likelihood ratio statistics. According to Jaeschke et al. [21], accuracy is moderate when the PLR is greater than 5.0 or the negative likelihood ratio (NLR) is less than 0.20, while accuracy is substantial when the PLR

Table 5 Accuracy statistics (with 95% confidence interval) for each level of the prediction model

Number of predictors present	Sensitivity	Specificity	Positive likelihood ratio	Probability of successful traction (%)
≥1	0.98 (0.80–1.00)	0.09 (0.04–0.16)	1.07 (0.99–1.16)	20.4
≥2	0.96 (0.78–1.00)	0.46 (0.36–0.56)	1.78 (1.47–2.17)	30.0
≥3	0.76 (0.55–0.90)	0.75 (0.65–0.83)	3.04 (2.04–4.53)	42.2
All 4	0.36 (0.19–0.57)	0.96 (0.90–0.99)	9.36 (3.13–28.00)	69.2

is greater than 10.0 or NLR is less than 0.10. In our study the PLR of identifying responder of mechanical lumbar traction increased with the presence of three out of four positive variables from 3.04 to 9.36 with the presence of all four variables. Hence, the objective of our study being to identify responders of mechanical lumbar traction, the statistic interest should be PLR. Accordingly, the threshold of all criteria met in the CPR should be used. The pre-prediction possibility of successful treatment in our study was 19.4%, post-prediction possibility with three or more criteria met was 42.2%, with all 4 criteria met was 69.2% according to the calculation stated by Go [13]. The mechanical lumbar traction as an adjunctive modality, 69.2% of treatment response rate should be considered clinically worthwhile. However, the CPR in our study represents a level IV CPR and requires validation in a separate sample before it can be implemented on a broad basis [30].

There are several potential limitations of our study. First, although the threshold of all criteria met in the CPR maximized the PLR (9.36), the confidence interval around the point estimated was big (3.13–28.00), thus making a strict interpretation of the result difficult.

Second, our sample was heterogeneous, uneven gender distribution (male 83.7%, female 16.3%) and wide spread of episode duration (1–1,040 weeks). The uneven distribution of gender may limit the implementation of the CPR to a male-dominated population. The wide range of episode duration with relatively small sample size did not allow us to have a homogeneous group of patients with regards to chronicity of their condition.

Third, we did not include distress as a variable in our study. Some authors stated that distress contributed about the same as fear-avoidance beliefs to the variance in disability scores (assessed by the Oswestry Disability Index) in both acute and chronic LBP [16]. Hence, in a prospective follow-up study of the cohort of acute LBP, distress was a significant prognostic factor of non-recovery at 3 months, whereas fear-avoidance beliefs were not [14]. However, the assessment of distress requires some professional personal, such as psychologist. Therefore, we did not include it in the current study. Certainly, it should be included in future study.

Fourth, although 37.2% of the variance of prediction was accounted for in this study, there was still more than 60% of variance remaining unknown. Therefore, the future study should be designed to explore more variance, in order to have a more accountable prediction model.

Fifth, the traction regime in this study only included only 3 sessions. Therefore, the usability of CPR cannot be easily extrapolated to other long treatment regimes.

Sixth, the traction force in the study regime was 30–40% of patient's body weight. However there is still a lack of agreement of the traction force that should be used in clinical practice. Using maximum traction force has not been shown to produce greater benefits compared to sham traction [1].

Finally, the small sample size (129 subjects) and relatively small number of responders (25 subjects) make the possibility of mass significance. It makes the validation study essential, before the CPR is applied to clinical practice.

Interpretation of current available research suggests that traction intervention is not appropriate for the majority of patients with LBP and, therefore, traction should not be widely used for patients with LBP [8]. Our pre-prediction response rate (19.2%) supports this belief. Thus, mechanical lumbar traction is an adjunctive treatment for most clinical practice. However, the further classification for traction approaches may warrant clinical practice outcomes, since the prone approach prediction rules [8] were far different from common used supine approach. We suggest that the result of our study should not be used in a multi-modality treatment regime. The CPR for the use of traction under those particular situations will require an independent prediction study. There is clinical worth while to conduct a study of CPR, which may well be predicting a subgroup of patients who will improve regardless of any form of physiotherapy treatment given.

Conclusion

Four predictors were identified for predicting short-term responders to mechanical lumbar traction. Based on the prediction model in this study, possession of all 4 predictors suggested increased probability of successful treatment. This CPR may significantly enhance the efficacy of clinical decision-making when considering mechanical lumbar traction as an appropriate intervention for patients with LBP.

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