

Comparison of sinew-strengthening exercise with cognitive-behavioral therapy for chronic nonspecific low back pain: protocol for a randomized controlled clinical trial

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Study protocol

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Abstract

Background Chronic low back pain is a common disease in clinic. The prevention and treatment of this disease requires a great deal of medical care resources, which is now the third medical economic burden in China. Although non-steroidal analgesics have been shown to be effective for chronic low back pain, considering the obvious side effects of these drugs, more and more patients are inclined to employ non-drug therapies. Typical examples are exercise therapy and cognitive-behavioral therapy (CBT). Exercise therapy of traditional Chinese medicine is an important part of non-drug therapy in China, such as sinew-strengthening exercise (SSE). Originating from traditional Chinese medicine exercise therapy, it has long been used for the prevention and treatment of chronic low back pain in Shuguang Hospital Affiliated to Shanghai University of Traditional Chinese Medicine (SGH), but it has not been validated by clinical trials. In this trial, we will seek to determine whether SSE is an effective and safe treatment option for persons with chronic nonspecific low back pain (CNLBP) by comparing it with CBT and explore a new method to CNLBP.

Methods/Design In this trial, we will randomize 480 adults with nonspecific chronic back pain to CBT and SSE arms (240 per group). Participants in both groups will be followed for 52 weeks after randomization with home practice. Interviewers will assess outcomes 4, 8, 26 and 52 weeks postrandomization. The primary outcome will be Roland-Morris Disability Questionnaire (RMDQ) with 26-week follow-up being the primary endpoint.

Discussion If SSE is found to be an effective treatment option for patients with chronic back pain, it will become a meritorious addition to the current limited treatment approaches available to patients with significant psychosocial contributors to their pain.

Background

Chronic nonspecific low back pain (CNLBP) is a disease with repeated low back pain and discomfort as its main clinical symptoms. Its causes cannot be attributed to pathology such as infection, tumor, osteoporosis, rheumatoid arthritis and fractures [1]. The prevention and treatment of this disease requires a great deal of medical care resources, and it is now the third medical economic burden in China [2]. CNLBP not only brings suffering and huge economic pressure to most patients, but also causes motor dysfunction and even leads to loss of self-care ability [3]. It may be related to atrophy and pathological changes of multifidus and striated muscles [4]. Both doctors and patients are dissatisfied with the status quo in the treatment of CNLBP [5]. Drug adverse reactions and other factors affect the prognosis of patients [6]. With the change of medical model, more and more attention has been paid to natural therapy.

In traditional Chinese medicine, Jin is an umbrella term of soft tissues including muscles, tendons and ligaments around the bones and joints, which is closely related to bones in physiology and pathology. It is an important rule to put equal emphasis on Jin and bones for the prevention and treatment of orthopedic

diseases. Therefore, this principle should apply to all stages of Jin and bone disease. It was proposed to give priority to tendon when tendon and bone lesions occur simultaneously [7]. Sinew-strengthening exercise (SSE) is a physical training method for the prevention and treatment of chronic low back pain created under the guidance of the theory of Jin, combining clinical practice with traditional Baduanjin (another common form of traditional Chinese exercise method containing eight individual movements) and modern kinesitherapy. This exercise benefits joints by physical training of tendons with simple movements. It is a vital part of the comprehensive plan for prevention and treatment of lumbar intervertebral disc protrusion in Shuguang Hospital Affiliated to Shanghai University of Traditional Chinese Medicine (SGH). Studies have shown that this exercise can alleviate pain in the low back and leg, increase the angle of straight leg elevation and improve the functions of the low back and leg; however, its exact mechanism is not clearly clarified [8].

Further research is needed on the effectiveness of SSE in CNLBP for the following reasons: (1) the large personal and societal impact of CNLBP, (2) the modest effectiveness of current treatments available, (3) the positive results of the trials in which researchers have evaluated cognitive-behavioral therapies (CBT) for back pain and (4) the growing popularity and safety, as well as the relatively low cost of mind-body therapies and physical exercises. To help fill this knowledge gap, we are conducting a randomized controlled clinical trial to evaluate the effectiveness and comparative effectiveness of SSE and group CBT for patients with CNLBP.

Specific aims

To compare the effectiveness of SSE and group CBT in decreasing Roland-Morris Disability Questionnaire (RMDQ) [9], back pain bothersomeness (0 to 10 scale), 36-Item Short-Form Health Survey (SF-36) and fat percentage of core muscle group outcomes.

Hypothesis: SSE will be more effective than group CBT in decreasing RMDQ, back pain bothersomeness, SF-36 and fat percentage of core muscle group in both the short term and long term. The rationale for this hypothesis is based on (1) the modest effectiveness of CBT for chronic low back pain found in past studies, (2) the positive results of the limited initial research evaluating SSE for CNLBP and (3) growing evidence that an integral part of SSE training (but not CBT training) - traditional Baduanjin - is effective for chronic low back pain [10].

Methods/design

Overview

We are conducting a randomized clinical trial in which individuals with CNLBP are randomly assigned to group SSE and CBT (Figure 1). Participants will be followed for 52 weeks after randomization. The primary outcome we will assess is RMDQ. Participants will be informed that the study researchers are

comparing “two different widely used pain self-management programs that have been found helpful for reducing pain and making it easier to carry out daily activities”.

Figure 1 Flowchart of the trial protocol

Study sample and setting

The primary source of participants for this trial will be SGH, a not-for-profit health-care organization with around 3.83 million outpatient visits every year in Shanghai. As needed to achieve recruitment goals, poster advertisement, telephone, social health lecturing, official website and WeChat will be employed. The subjects will be at the age of 20 to 70 years living in the areas served by SGH.

Inclusion and exclusion criteria

We are recruiting individuals from 20 to 70 years of age whose low back pain has persisted for at least 3 months. The inclusion and exclusion criteria were developed to maximize the enrollment of appropriate patients while screening out patients who have low back pain of a specific nature (for example, spinal stenosis) or a complicated nature or who would have difficulty completing the study measures or interventions (for example, psychosis). Tables 1 and 2 list the inclusion and exclusion criteria, respectively, as well as the rationale for each criterion.

In addition, we require that participants be willing and able to attend the CBT or SSE group during the whole intervention period if assigned to one of those treatments, and to respond to follow-up questionnaires according to the protocol.

Recruitment procedures

Based on SGH's administrative and clinical electronic case history, potentially eligible candidates with a visit in the recent 3 months (or longer than 3 months) can be identified to a provider that resulted in a diagnosis consistent with CNLBP. They will be informed of this trial in different ways including advertisement, social health lecturing, or other recruitment routes. If one is interested, a research specialist will call the potential participant to ask questions; determine eligibility; clarify risks, benefits and requirements of the study; and request informed consent. After the signed informed consent form has been obtained, the baseline telephone assessment is conducted.

To ensure that all these screened study participants remain eligible at the time that the trial begins, those who consent more than 14 days prior to the start of the intervention will be re-evaluated approximately 0 to 14 days prior to the first visit to reconfirm their eligibility. The primary concern is to exclude persons who no longer have at least moderate baseline ratings of pain bothersomeness and pain-related interference with activities. Those individuals who remain suitable to this trial and give their final informed consent will be included.

Randomization

All the volunteers will be trained with procedures and notes of both SSE & CBT by qualified investigators or instructors, and they will also be assessed whether they master these skills. After completing the baseline assessment, participants will be randomized in equal proportions to the SSE or CBT group. Each person will get a random number from 1 to 480 scheduled according to inclusion sequence.

Study treatments

Sinew-strengthening exercise

SSE, a practical exercise method frequently used in Department of Orthopedics in SGH, is conducted as procedures in Table 3.

Cognitive-behavioral therapy

It is reported that CBT is a valid way to deal with chronic pain problems [11], which emphasizes active, structured techniques to teach patients how to identify, monitor and change maladaptive thoughts, feelings and behaviors, with a focus on helping patients to acquire skills that they can apply to a variety of problems and collaboration between the patient and therapist. A variety of techniques are taught, including training in pain coping skills (for example, use of positive coping self-statements, distraction, relaxation and problem-solving). CBT also promotes setting and working toward behavioral goals.

The CBT intervention (Table 4) will consist of eight weekly 2-hour sessions that will provide (1) education about the role of maladaptive automatic thoughts (for example, catastrophizing) and beliefs (for example, one's ability to control pain, hurt equals harm) common in people with depression, anxiety and/or chronic pain and (2) instruction and practice in identifying and challenging negative thoughts, the use of thought-stopping techniques, the use of positive coping self-statements and goal-setting, relaxation techniques and coping with pain flare-ups. The intervention will also include education about activity pacing and scheduling and about relapse prevention and maintenance of gains. Participants will be given audio recordings of relaxation and imagery exercises and asked to set goals regarding their relaxation practice. During each session, participants will complete a personal action plan for activities to be completed between sessions. These plans will be used as logs for setting specific home practice goals and checking whether they complete during the week to be reviewed at the next week's session.

Instructors

All SSE instructors will have received either formal training in teaching SSE from a senior doctor who is experienced in treating patients for chronic low back pain in Department of Orthopedics in SGH or equivalent training. They will themselves be practitioners of SSE and will have taught SSE previously. The CBT intervention will be conducted by doctorate-level clinical psychologists with previous experience in providing CBT to patients with CNLBP.

Training and monitoring of instructors

All CBT instructors will be trained in the study protocol for the CBT intervention by qualified investigators from Rehabilitation Department in SGH, who are very experienced in administering CBT to patients with chronic pain. One of the investigators will train the SSE instructors in the adapted SSE protocol and supervise them. Each instructor will attend weekly supervision sessions, which will include discussion of positive experiences, adverse events, concerns raised by the instructor or participants and protocol fidelity. Treatment fidelity checklists highlighting the essential components for each session were created for both arms. A trained research specialist will use the fidelity checklist during live observation of every session. The research specialist will provide feedback to the supervisor to facilitate weekly supervision of the instructors.

Participant retention and adherence to home practice

Participants will receive a reminder call before each visit. They will be asked to record their daily home practice on weekly logs. Questions about their home practice during the prior week will also be included in all follow-up interviews. To maintain interviewer blinding, adherence questions will be asked after all outcome data have been recorded.

Measures

A variety of participant baseline characteristics will be assessed, including sociodemographic characteristics, low back pain history and expectations of the helpfulness of the treatments for CNLBP (Table 5).

We will assess a core set of outcomes for patients with spinal disorders (back-related function, pain, general health status, work disability and patient satisfaction) that are consistent with the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials recommendations for clinical trials of chronic pain treatment effectiveness and safety [12]. We will measure both short-term outcomes (8 and 26 weeks) and long-term outcomes (52 weeks). Participants will be paid 20 yuan for each follow-up interview completed to maximize response rates.

Primary outcome measure

The primary outcome measure will be RMDQ. This method has been found to be reliable, valid and sensitive to clinical changes. In RMDQ, 24 questions about low back pain will be asked to the patients. We will analyze and report primary outcomes in two ways. First, for our primary endpoint analyses, we will compare the percentages of participants in the two groups who achieve clinically meaningful improvement ($\geq 30\%$ improvement from baseline) [13] at each time point (with 26-week follow-up being the primary endpoint). We will then examine, in a secondary outcome analysis, the mean differences between groups on these measures at each visit.

Secondary outcome measures

Back pain bothersomeness will be measured by asking participants to rate how bothersome their back pain has been during the previous week on a 0 to 10 scale (0 = “not at all bothersome” and 10 = “extremely bothersome”). A literature showed that this bothersomeness measure is highly correlated with a 0 to 10 measure of pain intensity ($r = 0.8$ to 0.9) and with measures of function and other outcome measures [14]. As a result, this scale is sensitive enough in detecting changes in pain after treatment.

SF-36, known as a health survey summary, is a universal measurement scale with 8 aspects and 36 questions including physical functioning, role-physical, bodily pain, general health, validity, social functioning, role-emotional and mental health, which is one of the most commonly used standardized life quality assessment tools in the world. It has been translated to different languages since 1980s. Another health index in this short form is health transition to evaluate overall health change status in the previous year [15, 16].

Fat percentage of core muscle group is detected by Magnetic Resonance Hydrolipid Separation Imaging (MRHS), also named Dixon Technology, which is to perform two acquisitions by adjusting the time of echo (TE) in accordance with the difference of the hydrogen proton static frequency in water molecules and fat molecules in the magnetic field. The first acquisition obtains the transverse magnetization vector of the two protons in phase, i.e. the addition of water and fat signals. The second one obtains the transverse magnetization vector with opposed phase, which is the difference image of water and fat signals. The scanning device is high field superconducting nuclear magnetic resonance, Siemens skyra 3.0T MRI. The scanning parameters are as follows: horizontal axis Dixon sequence scan: TR5.36ms, TE1.24ms, flip angle: 9 degrees, FOV500mm×500mm, the number of layers: 44-60 layers, layer thickness: 5.0mm, interval: 1.0mm, scanning time: 12s×5. The reason for selecting fat percentage of muscle group as a secondary outcome measure is that skeletal muscle fat infiltration is associated with the onset of spinal degenerative diseases as it leads to the substitution of contractile muscle fibers by non-contracting tissues, which may affect spine stability [17]. Degeneration of paraspinal muscles is also closely related to the recurrence of low back pain [18].

Data collection, quality control and confidentiality

Data will be collected of the questionnaires from participants by trained investigators. We will attempt to obtain outcome data from all participants in the trial, including those who never attend or drop out of the therapies, those who discontinue enrollment in the study and those who move away. We will collect information at every stage of recruitment, randomization and treatment so that we can report patient flow according to the CONSORT (Consolidated Standards of Reporting Trials) guidelines [19]. In each visit, the investigators will ask the subjects to exercise in line with what they do at home to ensure that they practice in a correct way. Although the volunteers know his/her own group, the evaluators will see the baseline and questionnaire data only in order to keep their blind status and make the results reliable. To maintain the confidentiality of patient-related information in the database, unique participant study numbers will be used to identify patient outcomes and treatment data.

Protection of human participants and assessment of safety

Protection of human participants

The SGH Ethics Committee (EC) approved this study.

Safety monitoring

This trial will be monitored for safety by an independent Data and Safety Monitoring Board (DSMB) composed of a primary care physician experienced in CBT, a biostatistician and a clinical psychologist with experience in treating patients with chronic pain.

Adverse events

We will collect data on adverse events (AEs) from several sources: (1) reports from the CBT and SSE instructors of any participants' experiences of concern to them; (2) safety evaluation from laboratory examination; and (3) spontaneous reports from participants. The project coinvestigators and a SGH primary care internist will review AE reports from all sources weekly. Any serious adverse events (SAEs) will be reported promptly to the SGH EC, the DSMB and National Medical Products Administration (NMPA). AEs that are not serious will be recorded and included in regular DSMB reports. Any identified deaths of participants will be reported to the DSMB chair within 7 days of discovery, regardless of attribution.

Stopping rules

The trial will be stopped only if the DSMB believes that there is an unacceptable risk of SAEs in one or more of the treatment arms. In this case, the DSMB can decide to terminate one of the arms of the trial or the entire trial.

Sample size and detectable differences

Our sample size was chosen to ensure adequate power to detect a statistically significant difference between the two groups. We specified our sample size on the basis of the expected percentage of patients with a clinically meaningful improvement measured with the primary outcome measure (RMDQ) at the 26-week assessment (that is, at least 30% relative to baseline) [13].

A literature showed that 55% of CBT treatment group had clinically meaningful improvement on the RMDQ at 26 weeks [13]. We will have at least 80% power to detect a significant difference between SSE and CBT on the RMDQ if the ratio of SSE that improves with clinical meaning will be 20% higher than that

of CBT, which means that 66% (55%+55%*20%) of SSE group will have clinically meaningful improvement on the RMDQ at 26 weeks from our expectation.

The effectiveness rates of these two groups are compared. Assuming a 20% loss to follow-up, we plan to recruit a sample of 576 participants (288 per group). We will need 480 participants (240 in each group) to achieve 80% power to find SSE treatment different from CBT group on the RMDQ according to the formula

$$n_c = n_t = \frac{(z_{1-\alpha} + z_{1-\beta})^2 [p_t(1-p_t) + p_c(1-p_c)]}{(\varepsilon - \Delta)^2}$$

in which $\alpha=0.05$, $\beta=0.2$, p_t (the effectiveness percentage of test group) equals to 66%, p_c (the effectiveness percentage of control group) equals to 55%, and $\varepsilon = p_t - p_c$, that is to say, the rate difference that should be detected should at least be 11% and it is assumed that the optimum value $\Delta=0$ [20].

The primary outcome will be tested at the $P < 0.05$ level at each time point because they address separate scientific questions.

Statistical analyses

In our comparisons of treatments based on the outcome measures, we will analyze outcomes assessed at all follow-up time points. We will conduct the following set of analyses for both the continuous outcome score and the binary outcome (clinically significant change from baseline) including all follow-up time points (4, 8, 26 and 52 weeks). The SSE treatment will be deemed successful only if the 26-week time point comparisons are significant. The other time points will be considered secondary evaluations.

We will use an intent-to-treat approach in all analyses; that is, the assessment of individuals will be analyzed by randomized group, regardless of participation in any classes. In this trial, if a patient does not complete the treatment, the data will be carried forward with the last observation. This analysis minimizes biases that often occur when participants who do not receive the assigned treatments are excluded from analysis.

Discussion

In this trial, we will seek to determine whether an increasingly popular approach to dealing with stress – SSE – is an effective and safe treatment option for persons with CNLBP. Because it mainly focuses on

physical exercise, SSE has the potential to alleviate low back pain. We will also compare the effectiveness of SSE with that of CBT, which has been found to be effective for low back pain but mainly employed in SGH. If SSE is found to be effective and safe for those who suffer from chronic low back pain, it can be generalized to medical routine in more sites.

Trial Status

The protocol version number is V1.0 and its date is 20150423. Recruitment will start in October 2019 and will be completed in June 2021 as expected.

Abbreviations

AE: Adverse event; CBT: Cognitive-behavioral therapy; CNLBP: Chronic nonspecific low back pain; DSMB: Data and Safety Monitoring Board; EC: Ethics Committee; NMPA: National Medical Products Administration; PMR: Progressive muscle relaxation; RMDQ: Roland-Morris Disability Questionnaire; SAE: Serious adverse event; SF-36: 36-Item Short-Form Health Survey; SGH: Shuguang Hospital Affiliated to Shanghai University of Traditional Chinese Medicine; SSE: sinew-strengthening exercise;

Declarations

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

ZS, WY and HZ designed the study. WY is the principal investigator of the study. YZ wrote the SSE manual. CZ wrote the CBT manual. PP is the primary author of this manuscript. WY made significant contributions to the writing. All authors read and approved the final manuscript.

Ethics approval and consent to participate

The protocol for this trial has been approved by the Independent Review Board of SGH (2015-384-12-01). All participants will be required to give their informed consent before enrollment in this study.

Consent for publication

All presentations of case reports have consent to publish.

Availability of data and material

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

References

- [1] Wang X, Shu S, Fang FF, Gu W: **Correlation of lumbar vertebrae position perception to psoas muscles endurance and pain in chronic non-specific low back pain patients.** *Chin J Rehabil Theory Pract* 2017, **23**(7):820-823
- [2] Yang G, Wang Y, Zeng Y, Gao GF, Liang X, Zhou M, Wan X, Yu S, Jiang Y, Naghavi M, Vos T, Wang H, Lopez AD, Murray CJ. **Rapid health transition in China, 1990-2010: findings from the Global Burden of Disease Study 2010.** *Lancet* 2013, **381**(9882):1987-2015
- [3] Expert Group in Chinese Society of Rehabilitation Medicine Spinal Cord Committee: **Expert consensus on acute/chronic nonspecific low back pain in China.** *Chinese Journal of Spine and Spinal Cord* 2016, **26**(12):1134-1138
- [4] Rezazadeh F, Taheri N, Okhravi SM, Hosseini SM: **The relationship between cross-sectional area of multifidus muscle and disability index in patients with chronic non-specific low back pain.** *Musculoskelet Sci Pract* 2019, **42**:1-5

- [5] Mateu M, Alda O, Inda MD, Margarit C, Ajo R, Morales D, van-der Hofstadt CJ, Peiró AM: **Randomized, controlled, crossover study of self-administered Jacobson relaxation in chronic, nonspecific, low-back pain.** *Altern Ther Health Med* 2018, **24**(6):22-30
- [6] Zhang H, Liang X, Xu H, Li T, Chi LT: **The status of treatment of nonspecific low back pain.** *Chinese Journal of Ethnomedicine and Ethnopharmacy* 2017, **26**(7):59-61, 65
- [7] Zhou N, Fang M, Zhu QG, Shen GQ, Jiang SY, Cheng YW, Liu KP: **Biomechanical evaluation of waist back muscle for Tuina manipulation treating lumbar intervertebral disc protrusion.** *China Journal of Traditional Chinese and Pharmacy* 2012, **27**(3):562-566
- [8] Zhang JQ, Wang XD, Meng XY, Zhang YL: **Research on effects of "Qiangjingushengong" rehabilitation exercise in patients with lumbar disc herniation in remission stage.** *China Journal of Nursing Administration* 2013, **13**(10):736-737
- [9] He G, Zhang JX, Shen CL, Yang QG: **Reliability of Chinese version of the Rowland-Morris disability questionnaire for evaluating patients with low back pain.** *Chinese Journal of Spine and Spinal Cord* 2005, **15**(4):242-244
- [10] Liu WH, Shi XM, Yu J, Wang XJ, Li GX, Xue YY, Zhang L, Li M: **Exercise therapy in prevention and treatment of navy personnel with chronic low back pain.** *Med & Pharm J Chin PLA* 2018, **30**(11):10-13
- [11] Williams AC, Eccleston C, Morley S: **Psychological therapies for the management of chronic pain (excluding headache) in adults.** *Cochrane Database Syst Rev* 2012, **11**:CD007407
- [12] Dworkin RH, Turk DC, Farrar JT, Haythornthwaite JA, Jensen MP, Katz NP, Kerns RD, Stucki G, Allen RR, Bellamy N, Carr DB, Chandler J, Cowan P, Dionne R, Galer BS, Hertz S, Jadad AR, Kramer LD, Manning DC, Martin S, McCormick CG, McDermott MP, McGrath P, Quessy S, Rappaport BA, Robbins W, Robinson JP, Rothman M, Royal MA, Simon L, Stauffer JW, Stein W, Tollett J, Wernicke J, Witter J: **Core outcome measures for chronic pain clinical trials: IMMPACT recommendations.** *Pain* 2005, **113**:9-19
- [13] Ostelo RW, Deyo RA, Stratford P, Waddell G, Croft P, Von Korff M, Bouter LM, de Vet HC: **Interpreting change scores for pain and functional status in low back pain: towards international consensus regarding minimal important change.** *Spine (Phila Pa 1976)* 2008, **33**:90-94
- [14] Dunn KM, Croft PR: **Classification of low back pain in primary care: using "bothersomeness" to identify the most severe cases.** *Spine (Phila Pa 1976)* 2005, **30**:1887-1892
- [15] Ward MM, Hu J, Guthrie LC, Alba M: **Testing the construct validity of a health transition question using vignette-guided patient ratings of health.** *Health Qual Life*

Outcomes 2018, 16(1):2

- [16] Zhang YL, Chen ZQ, Sun Y, Zhou FF: **Correlation and change of quality of life and neurological function outcome for cervical spondylotic myelopathy after surgery.** *Chinese Journal of Spine and Spinal Cord* 2016, **26**(9):782-790
- [17] Hamrick MW, McGee-Lawrence ME, Frechette DM: **Fatty infiltration of skeletal muscle: mechanisms and comparisons with bone marrow adiposity.** *Front Endocrinol (Lausanne)* 2016, **7**:69
- [18] D'hooge R, Cagnie B, Crombez G, Vanderstraeten G, Dolphens M, Danneels L: **Increased intramuscular fatty infiltration without differences in lumbar muscle cross-sectional area during remission of unilateral recurrent low back pain.** *Man Ther* 2012, **17**(6):584-588
- [19] Boutron I, Moher D, Altman DG, Schulz KF, Ravaud P, CONSORT Group: **Extending the CONSORT statement to randomized trials of nonpharmacologic treatment: explanation and elaboration.** *Ann Intern Med* 2008, **148**:295–309
- [20] Jin PH, Chen F: *Medical Statistics Method*. 3rd edition. Shanghai: Fudan University Press; 2009

Tables

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Figures

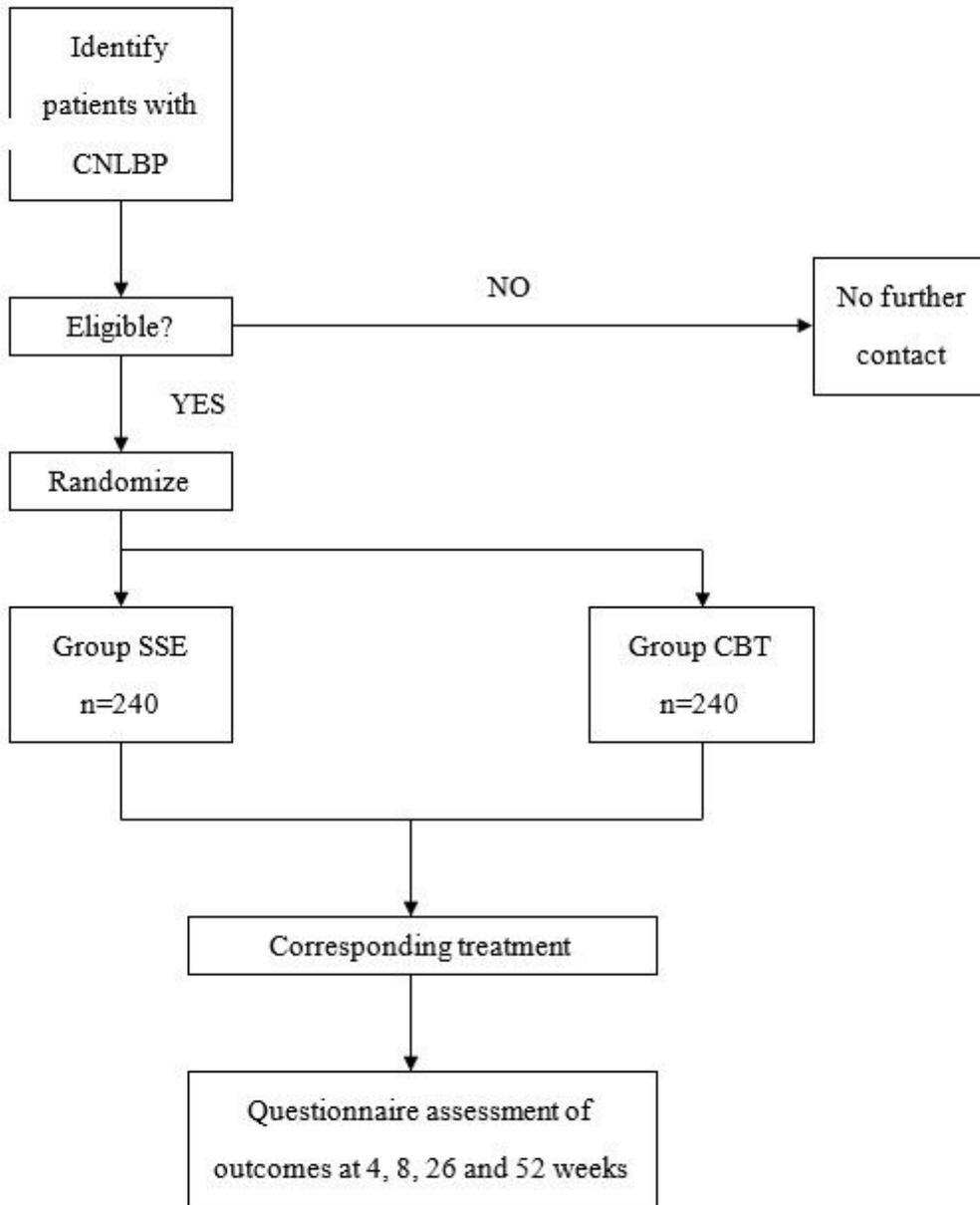


Figure 1 Flowchart of the trial protocol

Figure 1

Flowchart of the trial protocol

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