Review Article

Neurodynamics and mobilization in Stroke Rehabilitation– A Systematic Review

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Abstract:

Background

Stroke patients have residual impairments which results in disability. Being an upper motor neuron lesion the status of peripheral neural tension is not clearly studied thus far.

Objectives

The primary aim of the review was to establish whether there is clear understanding about the status of peripheral neural mechanics following stroke and Secondary aim of the study was to analyze the contribution of neural mobilization techniques as an intervention tool in stroke recovery

Strategy

The researcher searched the Cochrane Stroke Group Trials Register. In addition, the following electronic databases were explored: Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, CINAHL,Web of Science Proceeding, Science Citation Index Expanded, Physiotherapy Evidence Database (Pedro), REHABDATA and Google Scholar. The reviewer had searched relevant journals and conference proceedings and screened reference lists. To identify if there were any unpublished and ongoing trials a search on trials directories were

الملخص

خلفية البحث

هناك بعض الإعاقات المتبقية لمرضي السكتة الدماغية تؤدي إلى العجز. كون المحرك الرئيسي هيالخلايا العصبية إلا أن حالة التوتر العصبي الطرفي ليست مدروسة بشكل واضح حتى الآن.

الاهداف

إن الهدف الرئيسي من البحث هو تحديد ما إذا كان هناك فهم واضح لحالة الميكانيكا العصبية الطرفيةبعد السكتة الدماغية والهدف الثانوي للدراسة هو تحليل مساهمه تقنيات الحركة العصبية كوسيلة تدخل في علاج السكتة الدماغية.

استراتيجية البحث

قام الباحث بدراسة سجل تجارب السكتة الدماغية لمجموعةكوكران. بالاضافة إلى استكشاف قواعد البيانات الكترونية

التالية: سجل كوكران المركزي للتجارب الخاضعة للرقابة العلمية، وشبكة الاجراءات العلمية وفهرس الاستدلالات العلمية الموسعة وقاعدة بيانات العلاج الطبيعي ومحرك البحث جوجل. كما وقام الباحث بمراجعة المجلات المتعلقة بالموضوع ونتائج المؤتمرات وفرز القوائم المرجعية. وذلك لتحديد ما اذا كانت هناك أي تجارب جارية أو غير منشورة تبحث في الأدلة الموجودة.

معايير الاختيار

شملت الدراسات ما إذا كان هناك محاولة أجريت باستخدام اجراء اختبار التوتر العصبي وتقنيه الحركة العصبية لتحسين حالة مريض السكتة الدماغية.

جمع البيانات وتحليلها

تم استخراج البيانات من الدراسات المؤهلة من قبل باحث

undertaken.

Selection criteria

Studies were included if there was an attempt made using neural tension testing procedure and neural mobilization technique to improve the status of stroke patient.

Data collection and analysis

Data from eligible studies were extracted by a single reviewer. There were no specific outcome measures specified as inclusion criteria as there were only few studies that discussed our review content.

Main results

Studies which were a total number of 22 studies were screened, out of which 12 studies were selected for the review report. Out of the 12 studies 7 were RCTs, 3 Quasi experimental, 1 case report and 1 systematic analysis were identified to answer the review question.

Conclusions

This review concludes that there was no evidence documented in the past explaining the neural mechanics and periodic changes that take place following stroke. All the study except one concluded a positive therapeutic benefit of using neural mobilization. However, in consideration of their methodological quality, qualitative analysis of these studies exhibitedthat there is only limited evidence to support the use ofneural mobilization techniques.

Key words: Stroke, Peripheral Neural Mechanics, Neural Mobilization, Neural tension.

واحد. ولم تكن هناك نتائج محددةتقيس تماماً المعايير الضمنية حيث لم تكن هناك سوي دراسات قليلة ناقشت محتوي بحثنا.

النتائج الرئيسية

لقد تم فحص الدراسات التي بلغ عددها الإجمالي ٢٢ دراسة،واختيرت منها ١٢ دراسة لكتابة البحث. ومن بين الدراسات ال١٢ التي أجريت،هناك ٧ منها غير مكتملة و٣ شبه تجريبية ، و واحدة تقرير حالة. وتحليل منهجي واحد حول الإجابة عن سؤال البحث.

استنتاجات المؤلفين

يخلص هذا البحث إلى أنه لم تكن هناك أدلة موثقة في الماضي تشرح الميكانيكا العصبية والتغيرات الدورية التي تحدث بعد السكتة الدماغية. جميع الدراسات باستثناء واحدةتوصلت إلى فائدة علاجيةايجابية من خلال استخدام الحركة العصبية. غير أن التحليل النوعي لهذه الدراسات، بالنظر إلى جودتها المنهجية،أظهر أنه لا توجد سوى أدلة محدودة لدعم استخدام تقنيات الحركة العصبية.

الكلمات الرئيسية: السكتة الدماغية، الميكانيكا العصبية الطرفية، الحركةالعصبية، التوتر العصبي.

Introduction:

Neural tension is a procedure commonly used to describe dysfunction of the peripheral nerves. More recently, the word peripheral neural tension has given way to terminology of "Neurodynamics" which is a more accepted term referring to the symbiotic consideration of biomechanical, physiological, and morphological functions of the human nervous system (Butler DS, 2000; Shacklock MO, 2005). Researchers observed that nervous system is designedto adapt to mechanicalloads, and undergo typical mechanical events like elongation, sliding, cross-sectional change, angulation, and compression. When these dynamic protective mechanisms fail, the nervous system is vulnerable to neural edema, ischemia, fibrosis, and hypoxia, which may cause altered neurodynamics. (Butler et al, 1994) neural mobilization as a techniqueis being employed in almost every neuro-musculo-skeletal condition. In these lines, this review tries to focus on neurodynamic changes after stroke and on neural mobilization techniques employed in the treatment of stroke subjects. Cerebrovascular disease (CVA) commonly called as stroke is the third leading cause of death and disability in developed countries(Hoyert 1999). Hemiplegia is the primary motor manifestation of CVA, which is weakness of one half of the body contralateral to the site of cerebral lesion. It is well established that the stroke subjects do not recover to co morbid status most often. There are various intervention like Bobath approach, Roods approach, Proprioceptive neuromuscular facilitation techniques, motor relearning programme, functional approaches, constraininduced movement therapy are all employed I the treatment of stoke subjects. Yet the neural tension testing proceduresare not employed in assessment of hemiplegia and neural mobilization is not employed for management of Hemiplegia. Even after clear demonstration of the central nervous system involvement in peripheral nerve mobility there is no clear explanation of the neural mechanics following stroke. Butler, in 1995 stated that spasticity following stroke will result in nerve contractures. Thus, in this review a systematic analysis was done to find if there is any previous work done on altered neural mechanics following stroke and analysis was done to know whether the contribution of neural mobilization techniques as an intervention toolin stroke recovery.

Objectives:

Primary objectives

The primary aim of the review was to establish whether there is clear understanding about the status of peripheral neural mechanics following stroke

Secondary objectives

Secondary aim of the study was to analyze the contribution of neural mobilization techniques as an intervention tool in stroke recovery.

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

As there was a very few literature available in answering the review questions all types of study which related neural mechanics with stroke were included in the review.

The reviewer also included the studies, which related neural mechanics with spasticity and tonal abnormalities.

Types of participants

Studies done with subjects with incidence of stroke both acute and chronic of both the genders were included in the review. The review also included subjects who had spasticity because of traumatic brain injury too.

Types of intervention

Studies included in this systematic review will have these characteristics:

- Neural mobilization techniques
- Peripheral nerve mobilization techniques
- Neuro dynamic testing and interventions.

Types of outcome measures

Outcome measures that relates to the prognosis of stoke patients like motor recovery, balance, gait, sensory recovery, functional recovery, coordination, quality of life and activities of daily living were selected.

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

This review has drawn on the search strategy developed for the Stroke Group as a whole. Relevant trials were identified in the Stroke Group's specialized trials register. The last search for this review was carried out in June 2003. In addition the following electronic bibliographic databases were searched.

1. Cochrane Central Register of Controlled Trials (*The Cochrane Library,* Issue 4 2015)
2. MEDLINE 1995 to December 2015 (OVID)
3. EMBASE 1995 to December 2015 (OVID)
4. CINAHL 1995 to December 2015 (OVID)
5. Science Citation Index Expanded 1995 to December 2015
6. Web of Science Proceedings 1995 to December 2015
7. Physiotherapy Evidence Database (PEDro) 1995 to December 2015 (http://www.pedro.fhs.usyd.edu.au/)
8. REHABDATA 1995 to December 2015 (http://www.naric.com/search/rhab/)**w**

Table 1.Summary of all the studies included for the review

s. no	Author	Year	Title	Methods	Conclusion	Type	PS
1	Richard F. Ellis	2008	Neural Mobilization: A Systematic Review of Randomized Controlled Trials with an Analysis of Therapeutic Efficacy	Methodological assessment allowed an analysis of research investigating therapeutic efficacy of neural mobilization. Ten randomized clinical trials (discussed in 11 retrieved articles) were identified that discussed the therapeutic effect of neural mobilization	This review highlights the lack in quantity and quality of the available research. Qualitative analysis of these studies revealed that there is only limited evidence to support the use of neural mobilization	Systematic review	NA
2	Tomasz-Wolny	2010	Butler's neuromobilizations combined with proprioceptive neuromuscular facilitation are effective in reducing of upper limb sensory in late-stage stroke subjects: a three-group randomized trial	A total of 96 late-stage stroke subjects were randomly assigned to three groups. Intervention: The therapeutic programme in the control group was based on traditional post-stroke methods. The second group (experimental 1) received in addition individual therapy based on the proprioceptive neuromuscular facilitation method. The third group (experimental 2) received a combination: traditional therapeutic programme plus individual proprioceptive neuromuscular facilitation exercises plus neuromobilization of the affected upper extremity. All groups received 18 training sessions lasting about 45 minutes each	Application of Butler's neuromobilizations combined with proprioceptive neuromuscular facilitation showed greater effectiveness in reducing sensory deficits than proprioceptive neuromuscular facilitation or traditional therapy alone.	RCT	5
3	Godoi J	2011	Electromyographic analysis of biceps brachii muscle following neural mobilization in patients with stroke.	A pre-experimental study was carried out with pretest and posttest repeated measurements on five stroke victims, with Grade 1 and + 1 spasticity, according to the modified Ashworth scale. Electromyographicanalysis of the biceps brachii muscle was performed with the elbow flexed at 90 degrees, following by complete extension.	Neural mobilization was efficient in reducing myoelectric activity in the biceps brachii muscle in patients with stroke and may used by physiotherapists as an efficient method for treating patients with this pathology.	Clinical trial	NA

4	Jessica Castilho	2011	Analysis of electromyographic activity in spastic biceps brachii muscle following neural mobilization	Repeated pre-test and post-test EMG measurements were performed on six stroke victims with grade 1 or 2 spasticity (Modified Ashworth Scale). The Upper Limb Neurodynamic Test (ULNT1) was the mobilization technique employed.	When performed using contralateral techniques, neural mobilization alters the electrical signal of spastic muscles	Clinical repeated measures trial	NA
5	Yong-Jeong Kim	2011	Comparison the Initial Effects of Nerve Mobilization Techniques(NM), Static Stretching(SS) and Contract-Relax(CR) on Hamstring Flexibility and Walking Ability in Post-Stroke Hemiplegia Patients,	Eleven patients with hemiplegia were included in this study. Passive knee extension (PKE) range of motion and the sit and reach (SR) test were used to measure hamstring flexibility, while timed up and go (TUG) and the 10m walking (10MW) test were used to measure the subject's gait. Measurements on each test were assessed prior to the experiment, immediately following the experiment, and 30 minutes after the experiment. Analysis of the results utilized a repeated measures analysis of variance to examine hamstring flexibility and the difference in walking ability	This study suggests NM, SS, and CR techniques immediately improve hamstring length and flexibility while improving gait function in patients with hemiplegia	Clinical trial	NA
6	Jakob-Lorentzen	2012	Neural tension technique(NTT) is no different from random passive movements in reducing spasticity in patients with traumatic brain injury	10 spastic patients with brain injury were included. An RCT study with crossover design evaluated muscle tone measured by: 1) hand-held dynamometer; 2) Modified Ashworth Scale (MAS); 3) and ROM by; 4) angles of resistance onset "catch" (R1) compensatory movement (R2); and 5) 'subjectively perceived reduction in muscle tone'. Outcome measures were recorded by three raters before and after a single treatment session	An objective evaluation of NTT demonstrates that it does not reduce spasticity. However, it does increase ROM with the same effect as RPM	RCT	6

7	Jorge H. Villafañe	2012	Botulinum toxin type A combined with neurodynamic mobilization for upper limb spasticity after stroke: a case report	The patient underwent combined treatment with BoNT-A and NM of the upper limb in 6 monthly applications. Evaluation was performed pretreatment, 3 months after the first injection, 3 months after the second injection, and at a follow-up session 9 month after starting the treatment. The following outcomes were measured: pain by using a numeric rating scale, spasticity by the Modified Ashworth Scale for Grading Spasticity, acceptance and emotional reaction to the treatment by the Hospital Anxiety and Depression Scale, and functionality by ranges of motion. The patient improved in all outcomes after treatment, and results were maintained during the follow-up sessions	The combined NM and BoNT-A treatment appeared to decrease pain and improve joint ranges of motion during treatment for this patient. The patient showed decreased anxiety and depression during and after the treatment.	A case report	NA
8	LIU Zhongshu	2013	Effect of nerve mobilization plus rehabilitation therapy on function of lower extremity in patients with hemiplegia after stroke	Forty-nine stroke patients were randomly divided into observation group (n=25) and control group (n=24). Both groups were given conventional rehabilitation training, and observation group received treatment of nerve mobilization additionally. Composite spasticity scale(CSS) was used for assessing the ankle planter flexor, Fugal-Meyer motor assessment(FMA) for the lower extremity, Erg balance scale(BBS) for stability and modified Barthel index(MBI) for activities daily living(ADL) before and after the treatment results	Nerve mobilization combined with rehabilitation therapy in the treatment of stroke patients can decreaseanklespasticity and improve motor function of lower extremity, stability and activities of daily living	RCT	6
9	Hyun-Kyu Cha	2014	Effects of the Nerve Mobilization Technique on Lower Limb Function in Patients with Post stroke Hemiparesis	20 stroke patients were randomly selected based on selection criteria and divided into two groups. In the subject group (n=10), sciatic nerve mobilization with conventional physical therapy was applied to	study showed that sciatic nerve mobilization with conventional physical therapy was more effective for lower limb function than conventional	RCT	5

				patients. In the control group (n=10), only conventional physical therapy was applied to stroke patients	physical therapy alone in patient with post stroke hemiparesis		
10	SHI Jia-jia	2014	Effects of nerve mobilization techniques on lower limb movement function in patients with hemiplegia	Forty cases of patients with hemiplegia were randomly divided into two groups, 20 patients in each group. Both groups were treated with conventional drugs and rehabilitation training and observation group given peripheral nerve mobilization techniques of lower limb additionally.10-m maximum walking speed, lower limb Fugle-Meyer assessment(FMA) on the hemiplegia side, the hamstrings and tibialis anterior muscle maximum isometric contraction EMG signal values(iEMG) were measured before and after treatment	Nerve mobilization techniques can obtain more satisfactory effects in restoring lower limb movement function of patients with hemiplegia	RCT	5
11	Yunhyeok Shinu	2016	The Effects of Sciatic Nerve Mobilization on Hamstring Flexibility, Lower Limb Strength and Gait Performance in Patients With Chronic Stroke	Eleven patients with hemiplegia Sixteen subjects were recruited for this study. The subjects were randomly divided into two intervention groups and underwent either of the following two interventions: sciatic nerve mobilization or static stretching of the hamstring. We assessed hamstring flexibility, lower limb strength, and gait performance using a digital inclinometer, a hand-held dynamometer, and the 10-meter walk test, respectively. Subjects had a 24-hour rest period between each session in order to minimize carryover effects. Measurements for each test were assessed prior to and immediately after the intervention sessions.	Study indicated that the sciatic nerve mobilization technique may be more effective in muscle activation of the knee extensor muscle and knee flexor muscle than hamstring static stretching technique in patients with chronic stroke	RCT	6

12	Kelson-Carvel-hedo,	2016	Effects of muscle strengthening, neural mobiliza-tion and vibration in patients with stroke	40 subjects were selected, of both genders divided randomly into four groups: muscle stretching group, neural mobilization group, vibratory stimulation group and control group. Before and after the intervention were assessed for balance and functional mobility through berg balance and time UP and GO test	It can be concluded that the three techniques applied brought immedi-ate benefits to the public of the study participants with stroke squeal.	RCT	5

Method of the review

Data Extraction:

A single reviewer independently selected the studies to be included in this systematic review and applied the selection criteria to the studies retrieved by the electronic search. The methodological quality of studies was assessed by the same reviewer. The reviewer contacted the authors of the selected studies when the article does not contain information on the methodological criteria by e-mail for additional information. Additional information was obtained including an indication as to whether different trialists were involved in intervention, outcome assessment, and reporting. Assessments were made of the validity and reliability of any outcome tool, scale or method employed by trialists of selected studies. Where missing information could not be retrieved the criteria were scored as 'unclear' or 'unknown'.

Data were extracted by reviewers which included the methods and methodological quality information, and the following;

Participants: Number recruited and randomized, Average age; gender; stroke type, affected side; time from stroke to trial entry;

Interventions:Type of training - cardiovascular/strength/mixed;exercise mode; training *frequency;* training duration; training intensity; upper or lower limb training; affectedand/or unaffected side trained.

Setting: Inpatient or outpatient; supervised or self-lead; homebasedor hospital based.

Outcome measures: For continuous variables baseline values and measures of variability (mean and standard deviation (SD) or standard error (SE)) were recorded. If the SD of the mean difference was not specified it was calculated from the baseline data and follow-up data.

Quality Assessment

Assessments of quality were completed by the reviewer. Each study was evaluated using the previously validated Pedro score to assess the completeness and quality of reporting of RCTs as well as to assess for potential bias in the trial. The pedro score which was devel-

oped by central evidence based physiotherapy consists of 11 item scale which is valid, reliable and versatile tool in rating RCTs for the Pedro database. In many systematic reviews Pedro score has been used as a measure of methodological quality.

Results:

Selection of studies

The analysis of the review clearly indicated that the volume of research concerned with neuro mechanics following stroke was nil to the researchers knowledge. Further the amount of literature support and the quality of literature that supports neural mobilization technique as a tool in stroke rehabilitation is very limited. A total number of 22 studies were screened out of which 12 studies were selected for the review report. Out of the 12 studies 7 were RCTs, 3 Quasi experimental, 1 case report and 1 systematic analysis were identified to answer the review question. The summary of all the studies included for the study are illustrated in Table 1.

Methodological quality

Each paper was reviewed for methodological quality and represented by IVS as briefed in Table2. Out of 12 studies 7 of them were reviewed for IVS.

Study Characteristics

All studies used different methods of application of neuralmobilization techniques like cervical lateral glides, slump sliders, peripheralnerve sliders and some studies chose to combinetechniques with other techniques like home-based neural mobilizationexercises, contract and relax techniques, vibration, strengthening techniques, static stretching. In one of the study in addition to neural mobilization techniques Botox was used. Therefore, all twelve studies were clinically and therapeuticallyheterogeneous, necessitating a qualitative analysis for summarizing the results. Table 4 contains details of study characteristics.

Therapeutic Efficacy

Out of the 7 RCTs only one (Jakob-Lorentzen) reported a negative result stating that the neural mobilization technique does not reduce spasticity. However, he concluded that it does increase Range of motion with the same effect as relaxed passive movements. One case study demonstrated that use of Botox and NM techniques were very effective in decreasing pain and improving joint range of motion during treatment for patients with stroke. The study also reported that the patient showed decreased anxiety and depression during and after the treatment which may be attributed to the drug effect and limbic system influence. One systematic review was included in the study which concluded that there was a lack in quantity and quality of the available research in neural mobilization. In the Qualitative analysis they revealed that there is only limited evidence to support the use of neural mobilization. There were three quasi experimental studies which are in the sup-

port of neural mobilization techniques. In the present reviewit's learnt that various terminologies were synonymously used for Neural Mobilization technique like Neural tension technique, neurodynamic mobilization, nerve mobilization technique.

Discussion:

Methodological Quality assessment was done for each paper and a quality score (QS) as a total of positive scores for 10 of the 11 items are given by the reviewer. Unlike the other items, Criterion One of the PEDro scale associates with the external validity and was not used in the final total PEDro score. QS for each paper is included in Table 2. The various items of the PEDroScore deal with different features of RCT study including internal validity, external validity, and statistics. Toenable quantitative analysis of the methodological quality of a systematic review, van Tulder et al recommended the analysis of the internal validity criteria of any rating tool. For the PEDro Scale, seven items concern to internal validity were identified. These seven items include items 2, 3, and 5 through 9 (Table 2). An internal validity score (IVS) has also been used in other systematic reviews to allow calculation of the number of internal validity criteria met for that rating system and to thereby give an estimation of methodological quality. It was decided to evaluate an IVS for this review based on the relevant internal validity criteria of the PEDro Scale. The positive scores of each of these seven items were added simultaneously to calculate the IVS (Table 3).

To stratify methodological quality, the summated score of the 7-item IVS, intended from the initial PEDro score (QS), was dispensed into three categories. A study of high methodologicalquality obtained IVS values of 6–7, a moderatequalityobtained IVS values between 4–5, and a limited qualitywas attained between 0–3. This decision was made based on even cut-off points between 0 and 7. The analysis showed that there was no blinded studies. In all the studies groups were not similar at baseline which was a major bias. There were no enough long term follow up with only 45% of the studies had a reasonable follow up. There were 4 studies done from Korea and two from china. There were few more studies which were done in native language. The reviewer omitted studies which were not translated into English.

Stroke is an upper motor neuron lesion with very less manifestation on lower motor neurons. But secondary complication does take place in the neural mechanism due to spasticity and abnormal attitude of the extremities. Stroke rehabilitation is mainly concerned with motor rehabilitation. Motor rehabilitation comprises of voluntary control, balance and postural control training. It is evident from the study that neural tension testing has been proved to be effective in restoration of motor functions in stroke. This is achieved by its direct effect on the tone of the muscle which is evident from the review. Neural mobilization has improved the passive

range of motion much better than the active range of motion. Few studies have compared neural mobilization technique with conventional physiotherapy and few studies have used few more techniques along with neural mobilization technique like proprioceptive neuromuscular facilitation techniques and neurodevelopmental therapy. When discussing about the two components of neural mobilization namely diagnostic and therapeutic, there was no evidence found from the review for analyzing neural tension testing as a diagnostically significant tool in stroke subjects. It can be clearly seen that the area is still under explored and needs more research. Whereas the therapeutic part of neural tension testing has been explored to a better extent than the Diagnostic part. The efficacy of neural tension testing as an intervention tool has been tested in both upper Limb as well as lower limb. The future study can concentrate on changes in the neural interfaces and the property of the nerve following the stroke. Neural tension testing has been proved to be effective in reducing the pain which is an important criterion in motor rehabilitation and about a significant improvement in the psychological quotient of the stroke subjects.

Table 2.PEDro Scores for RCTs

Author	1	2	3	4	5	6	7	8	9	10	11	QS	IVS	Methodological quality
Tomasz wolny	1	1	0	0	0	0	0	1	1	1	1	5	3	**Limited**
Jakob Lorentzen	1	1	1	0	1	1	0	1	0	1	1	6	5	**Moderate**
LIU Zhong-shu	1	1	1	0	0	0	0	1	1	1	1	6	4	**Moderate**
Hyun-Kyu Cha	1	1	1	0	0	0	0	0	1	1	1	5	3	**Limited**
SHI Jia-jia	1	1	1	0	0	0	0	0	1	1	1	5	3	**Limited**
Yun-hyeok Shin	1	1	1	0	0	0	0	1	1	1	1	6	4	**Moderate**
KelsonCarvelhedo	1	1	0	0	0	0	0	1	1	1	1	5	3	**Limited**

Table 3. Number and percentage of the studies meeting each PEDro criteria.

s.no	Criteria	Number Meeting criterion (N)	Percentage meeting PEDro Criteria criterion (%)
1	Eligibility criteria specified (yes/no)	7	63
2	Subjects randomly allocated to groups (yes/no)	7	63
3	Allocation was concealed (yes/no)	5	45
4	Groups similar at baseline (yes/no)	0	0
5	Subjects were blinded to group allocation	1	9
6	Therapists who administered therapy were blinded (yes/no)	1	9
7	Assessors were blinded (yes/no)	0	0
8	Minimum 85% follow-up (yes/no)	5	45
9	Intent to treat analysis for at least 1 key variable (yes/no)	6	54
10	Results of statistical analysis between groups reported (yes/no)	7	63
11	Point measurements and variability reported (yes/no)	7	63

Recommendation for future studies

Future studies can concentrate on doing an extensive analysis of the neural mechanical derangement prevailing in stroke subjects. This have to be done giving due consideration to the duration of stroke ailment, tone, musculoskeletal status, voluntary control and so on. The effectiveness of neural mobilization technique as an intervention tool in stroke rehabilitation has to be studied in elaboration with more number of subjects with a homogenous population.

Conclusion

This systematic review of the literature analyzed two important scenarios namely neural mechanics following stroke and neural mobilization as an intervention in stroke rehabilitation. This review concludes that there was no evidence documented in the past explaining the neural mechanics and periodic changes that take place following stroke. All the study except one concluded a positive therapeutic benefit from using neural mobilization. However, in review of their methodological quality, qualitative analysis of these studies exhibited that there is only limited evidence to support the use of neural mobilization techniques.

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