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Research Article

Active, Bilateral, and Sequential - Neural Mobilization (ABS-NM): a Novel Therapeutic Approach and its Clinical Rationale

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Abstract

Aim: The aim of the study was to rationalize and examine active, bilateral, and sequential neural mobilization as a tool for examination and treatment of the peripheral nervous system, especially the neurodynamically responsive structures. We looked at the effectiveness of battery of self -administered techniques using active, bilateral, and sequential pattern (ABS-NM) in conditions like cervical radiculopathy, brachial plexus related neural pain and musculoskeletal conditions indicative of compromise of brachial plexus.

Need of the study: Active movements are the main cause of the symptomatology however all the tests are passive in nature. Neurodynamic tests involve passive manoeuvres, but it has been found that whenever patient is moving actively, they tend to worsen their symptoms and there is reproduction of pain; mainly due to involvement of active structures like muscles, muscular-fascia and tendons which cover the brachial plexus and glide along its nerves. The use of extremities is always bilateral during daily activities in an active sequential manner and follows Bevor's axiom.

Methods: The battery of the tests was developed from extensive review of literature and expert consensus on the brachial plexus anatomy, biomechanics, and clinical assessment using passive neural tension tests. Case studies were done to find out the effectiveness of this technique using measures of pain and disability like numeric pain rating scale (NPRS), and neck disability index (NDI).

Results: The ABS-NM has shown significant effect on the studied parameters – NPRS and NDI for two cases of cervical radiculopathy.

Conclusion: ABS-NM works as a therapeutic and diagnostic battery and proved active feedback to the individual from muscle contraction and movement.

Keywords: Brachial Plexus; Neural Mobilisation; Sliders; Tensioners; Structural Differentiation; Active Tension Tests

Introduction

Neural tension was used initially for the tests which were done to check neural compression [1]. Michael Shacklock described the term "neurodynamics" to include the neuro-biomechanics and physiology [2]. Neurodynamics refers to the interaction between different parts of nervous system and the relationship of the nervous system with musculoskeletal problems. Movements may produce tension on various structures like nerves, muscles, tendons, and ligaments. James Cyrianx developed the concept of active and passive structure as a cause of pain [3]. Passive neural tension is diagnostic for nerve compression. Active movement lead to muscular contraction and neural tension similar to activities of daily living. This aspect is used for assessment and treatment by ABS-NM.

There are two parts of ABS -NM [3]

Diagnostic Neurodynamics- It is essentially a clinical application of active mechanics and neuro-muscular physiology as they relate to each other and are integrated with activities of daily ADL function.

Therapeutic Neurodynamics- Defined as local effects of body movements on nervous system in a way that is therapeutic to a specific region. It is antagonistic movement of the aggravating movement as seen in diagnostic neurodynamics.

The three primary events in the nervous system in relation to neurodynamics are- tension, sliding and compression [4].

The presentations of mechanical neck pain is associated with activities of daily living and it is examined by physical therapists using history, and physical examination, the findings are confirmed by the imaging and electrodiagnosis. There is poor reliability of the subjective findings and muscular and range of motion serve better for assessment. [5].

A neurodynamic test is a series of body movements that produces mechanical and physiological events in nervous system according to movement of the test. These tests are used to gain an impression of the mechanical performance and sensitivity of neural structures and their related interfacing and innervated tissues in relation to musculoskeletal and central nervous system (CNS). Neural events which occurs during these tests, follows a sequential pattern. Sequence of the movements during these neurodynamic tests, involves neural sliding and gliding manoeuvers. In order to reduce the amount of tension being placed on the nerve, the nerves move down the tension gradient. For example - a slider for brachial plexus in median nerve neurodynamic test position, would incorporate ipsilateral lateral neck flexion of cervical spine and elbow extension which is the distal slider. Neural mobilisation techniques actually help in designing plasticity of nervous system. The main aim of these neural mobilisation is that it helps to increase the flexibility of collagen which helps in maintaining the integrity and movement of nerve as per its surrounding anatomical structure.

There is a point of convergence which is a site at which the displacement of a neural structures relative to bone reaches zero. Also, forces and range of movement of the joint are significant variables in neurodynamic testing. For example, if elbow and shoulder joints are positioned so as to offer relaxation to the median nerve, it is observed that in this case the wrist movements will not greatly influence brachial plexus. However, if patient is asked to position his shoulder in abduction, elbow in extension, the forces tend to get transmitted to the brachial plexus with a very minute movement at wrist.

The body movements which are active in nature are more demanding because of the bilateral and symmetrical nature as well as the increased tone of the muscles, it may lead to shear and tension of the terminal nerves leading to the symptomatology.

Methods

The battery of the tests was developed from extensive review of literature on the brachial plexus anatomy, biomechanics, and clinical assessment using passive neural tension tests.

Case studies were done to find out the effectiveness of this technique using measures of pain and disability like numeric pain rating scale (NPRS), and neck disability index (NDI).

Cases were administered active bilateral sequential neural mobilization as per our specific protocol and method.

Mechanisms of neurodynamic tests

Sliders and tensioners

The neurodynamic techniques which includes sliders and tensioners can be both one-ended and two ended. The main concept behind one ended sliders is that most of the neural sliding occurs in the mid-range of a neurodynamic movement. The two-ended sliders is produced by applying tension to the neural structure at one end while at the other end, tension is released by letting it go. This manuvers not only helps the neural tissues to slide towards the direction at which the movement is first initiated, but also helps in dissipating the forces to the appropriate areas. Example for this is cervical extension.

Slider techniques are very helpful for patients in whom pain is the major complaint relating to neural dysfunctions. The slider techniques are mostly larger in amplitude which is done to ensure that neural structure under considerations returns to its normal resting position and moves to a greater extent. These techniques serve as a primary mobilization aimed at treating the dysfunction. They are used to reduce the after effects of mobilization because sliders help to improve oxygenation to the tissues and removing inflammatory exudate which develops in the neural tissues.

The neural tension in the one-ended tensioners has the advantage to the physiotherapist in that the tension in the neural structures increases mainly at the outer range of neurodynamic test. In the ULTT postion for median nerve, example of this could be wrist and finger extension at the end range. However, two-ended tension techniques are more effective as they help to elongate both sides of the neural container. In the ULTT for median nerve, two ended position would comprise-wrist and finger extension, along with contralateral lateral flexion of the cervical spine. These tension techniques are wider amplitude, this is not done to enter extremes of ranges of motion but, to withdraw to a point of low tension each time the movement is being repeated. Hence, the neural structures which are tensed are off-loaded more than being tensed, thereby facilitating a faster recovery from pain.

Response of the neurodynamic tests

The two most important categories of the response of these neural tension tests are in terms of positive and negative. These two classifications help to rule out whether the response is of neurodynamic origin or is musculoskeletal. These tests are normally positive in patients with no symptoms initially, i.e., asymptomatic patients. A common observation in the patients in whom there is no as such provoking symptoms, and if the nerve is subjected to

pull or tension, then mechanosensitivity comes into play and as a result, the test response is positive in normal subjects also. Mechanosensitivity is a primary mechanism by which the nervous system becomes a source of pain with certain postures and movements. This is due to production of afferent impulses from neural structure for processing in the CNS.

- **Musculoskeletal Response:** The symptoms which are aggravated while performing the neurodynamic tests are established with the concepts of structural differentiation to be musculoskeletal. An example is provocation of symptoms in case of median nerve tension tests for carpal tunnel.
- **Neurodynamic Response:** Effect of structural differentiation.

The major criteria for neurodynamic response is - symptom reproduction, range of motion analysis, and palpable resistance, which should change by some factor whenever differentiating manuvers is performed. An increase or decrease in these criteria marks the response of the tests. So, it is important to know what normal and abnormal response of these neurodynamic tests is. It has been reported in the literature that the normal neurodynamic response is positive to structural differentiation.

Whereas, in terms of abnormal response, the reproduction of symptoms, resistance pattern or range of motion all of them shows a positive response to structural differentiation, however they differ from those occurring in normal individuals. If a patient has only one side involvement, then that means there must be significant asymmetry in the criteria mentioned above. At times, when the problem is in midline where there can be bilateral involvement as well; there can be symmetrical presentation, which reduces value of asymmetry in making a diagnosis. So, the therapist relies on the clinical presentation of the individual patient, keeping in mind that if these symptoms were present unilaterally, bilateral techniques could be used.

- **Overt abnormal response (OAR):** The overt abnormal response is believed to be the "smoking gun" for neurodynamic tests. It involves, reproduction of patient's symptoms with a positive structural differentiation. This kind of response is a clear indication towards the fact that there is some underlying pathology in the nervous system, which is leading to aggravation of symptoms each time the test is being performed on the patient.
- **Covert abnormal response (CAR):** The covert abnormal response, as reported in the literature is "circumstantial evidence" for neurodynamic test. Although the response obtained hints towards neural abnormality which may be considered a comparable sign, it does not reproduce patient's symptoms. The abnormality could be in terms of significant asymmetry, palpable resistance, provocation of symptoms in abnormal locations etc. An example could be a patient complaining of ache in the anterior aspect of forearm with the ULTT for median nerve, which is differentiated to be positive, however they could experience severe pain possibly a grade of 8 or 9 on VAS with daily arm movement. The ache is accompanied by reduced range of wrist extension, which increases with contralateral lateral neck flexion. This is a typical case of covert response because there could be some underlying neuropathodynamics.

Study type: Explorative and Descriptive study, RCT
Study design: Review and Case study.
Conditions: Cervical radiculopathy, brachial plexus associated nerve root pain.
Intervention:

1 Active, bilateral, sequential neural mobilisation using different neural mobility patterns and BPNT tests.
2 Study arms: Active comparator: Active neural mobilisation of brachial plexus.

Sequence	Active Movements	Derived from (name of the test)	Structure of BP affected	Reference x y z., *et al*. year
1	Shoulder elevation with neck lateral flexion	Active Quick test	Median nerve (C5, C6 and C7).	Butler., *et al*. DS (1991) Mobilisation of the Nervous System
2	Forearm supinated with elbow at 0-degree extension	Watch the Watch test	Median nerve (Medial root)	Butler., *et al*. DS (1991) Mobilisation of Nervous System.
3	Kneeling on floor with forearm pronation and cervical flexion and extension	Crawl on the floor	Median nerve (C6 to T1).	Butler., *et al*. DS (1991) Mobilisation of Nervous System.
4	Towel stretch in standing erect with elbow 90-degree flexion.	Dry the back	Ulnar nerve mobiliser (C8 to T1).	Butler., *et al*. DS (1991) Mobilisation of Nervous System.
5	Ulnar nerve glide-Making a face mask.	Sunglass position	Ulnar nerve (C8 to T1).	Butler., *et al*. DS (1991) Mobilisation of Nervous System.
6	Clasped hands with internally rotated shoulder	Pumping water.	Radial nerve (C5, C6, C7, C8 T1).	Butler., *et al*. DS (1991) Mobilisation of Nervous System.

7	Abduction and external rotation of shoulder same as Apley Scratch test	Back massage	Radial nerve mainly C7.	Butler., *et al*. DS (2000) The Sensitive Nervous System: NOI Publications.
8	Making fist with wrist ulnar deviation	Standing March	Musculocutaneous nerve (C5 to C7).	Butler., *et al*. DS (2000) The Sensitive Nervous System: NOI Publications.
9	Shoulder internal and external rotation with forward bending	Figure of eight swirls	Radial nerve mobiliser (C5 to C7).	Butler., *et al*. DS (2000) The Sensitive Nervous System: NOI Publications.
10	Shoulder in 90-degree abduction bilaterally with neck flexion	Look at your hands	Median nerve (C6 to T1).	Butler., *et al*. DS (1991) Mobilisation of the Nervous System.

Number	Intervention	Studies per intervention	Evidence for intervention.
1.	Active nerve and flexor tendon gliding exercises	Baysal O., *et al*. (2006); 60:820-828-Int); national J Clin Practice	Limited (level 3)
2.	Cervical contralateral glide-neural mobilization	Coppieters., *et al*. (2003); J. Ortho Physical Therapy, Vicenzino., *et al*. (1996)	Limited (level 3)
3.	Combination (neural tissue manual therapy, shoulder oscillations, cervical contalateral glide).	Allison., *et al*. (2007)-An RCT for cervico-brachial pain patients.	Insufficient (level 4)
4.	Upper limb tension tests ULTT for brachial plexus neural mobilization.	Tal-Akabi and Rushton., *et al*. Manual therapy J. (2000), Dreschler., *et al*. an RCT of clinical interventions, J. sports Rehabilitation (1997).	Limited (level 3)

Table 1

Procedure: The patient was taught and being demonstrated these tests for neural mobility which were to be performed bilaterally. In all of these tests, the positioning of patient was standing.

Median nerve testing

Active quick test: It is the commonest example of structural differentiation. In this test if the patient experiences symptoms upon shoulder elevation, which are further worsened by neck lateral flexion on the contralateral side or extending wrist, then we can infer that these symptoms are from a neurogenic source i.e median nerve roots of brachial plexus (mainly C6, C7, C8, T1).

Watch the watch test: It is one of the most recommended postion for putting stress on the median nerve. This is also actively one by the patient as shown below.

Crawling on the floor: Crawling is a strong functional median nerve mobiliser, the balancing with bilateral arms create a slider movement similar to that of ULNT for median nerve. The patient firstly, keeps the head erect while looking in front, in the second position, neck is flexed as shown.

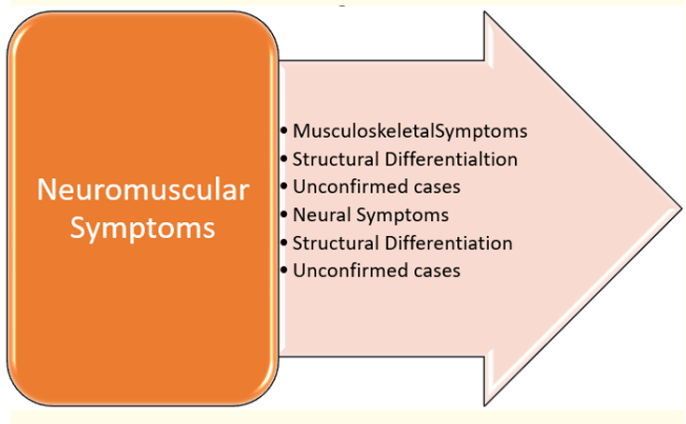

Figure 1: Flow Chart for diagnosis of symptoms which may respond to Active Bilateral Sequential Neural Mobilization.

Figure 2: Active test performed by patient (Right side).

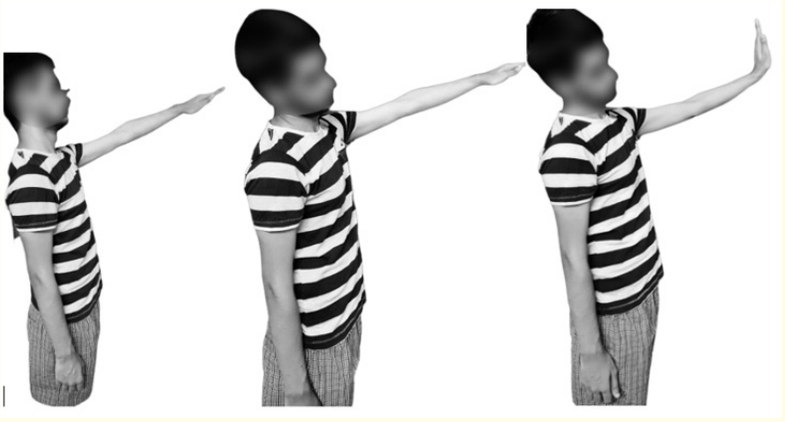

Figure 3: Active test performed by patient (left side).

Figure 4: Bilateral (both left and right sided) test for median nerve.

Figure 5: For performing crawl on floor test, patient uses both the extremities.

ULNT (MEDIAN1)- Sequential pattern involves.

- Shoulder abduction
- Wrist/finger extension
- Forearm supination
- Shoulder external rotation
- Elbow extension
- Structural differentiation- cervical side bending and releasing wrist extension.

Figure 6: Positioning for ULTT1(Median nerve).

ULNT(MEDIAN2)- Sequential pattern involves

- Shoulder girdle depression.
- Shoulder extension.
- Shoulder external rotation and forearm supination.
- Wrist/ finger extension.
- Shoulder abduction.
- Structural differentiation- cervical side bending, release shoulder girdle depression and release wrist extension.

Figure 7: Positioning for ULTT2 (Median nerve).

Ulnar nerve testing

Sequential tests for performing ulnar nerve mobilisation are.

Figure a

Step 1: Shoulder abducted to 90 degrees, elbow in extension, forearm supination (a) left side, (b) right side.

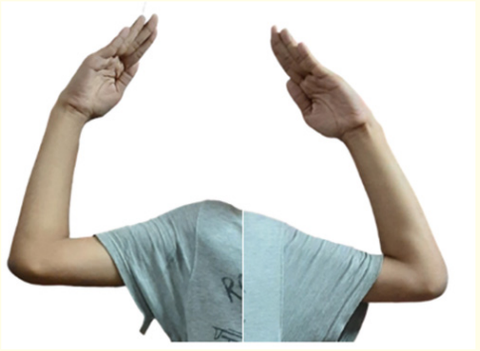

Figure b

Step 2: Shoulder in abduction, elbow flexed to 90 degrees with palm facing towards the face; (a) right side (b) left side.

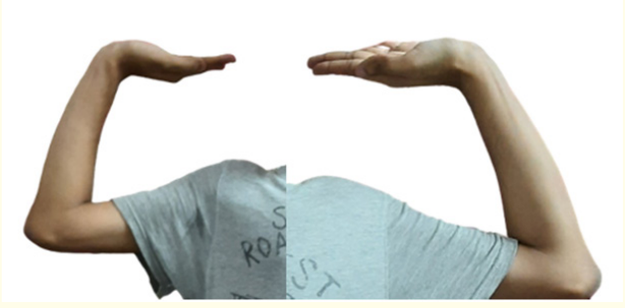

Figure c

Step 3: Patient asked to rotate the palm of the hand outwards, while maintaining wrist in slight flexion facing towards the face; (a) right side, (b) left side.

Step 4: Now the palm of the hand faces upwards with elbow in slight flexion; (a) right side, (b) left side.

Figure d

Figure e

Step 5: Elbow in extension, shoulder abducted to 90 degrees with wrist in flexion; testing for right (a) and left(b).

Dry the back

This is one of the position for testing ulnar nerve and neural mobilisation of ulnar nerve.

Figure 8: DRY THE BACK- A position for ulnar nerve mobilisation.

Sunglass position: This is considered probably the best neural mobilisation technique for ulnar nerve. Whenever patient performs these manoeuvers bilaterally, a lot of stress is being placed on the ulnar nerve.

Figure 9: Ulnar nerve glide technique.

ULNT(ULNAR): Sequential pattern for performing this include

- Wrist/finger extension
- Forearm pronation
- Elbow flexion
- Shoulder external rotation
- Shoulder girdle depression
- Shoulder abduction
- Structural differentiation - Cervical sidebending - Release shoulder girdle depression - Release wrist extension.

Figure 10: Bilateral sequence of ulnar nerve testing.

Radial nerve testing

Sequence for radial nerve mobilisation are

Step 1: Patient standing with body in relaxed position.

Figure f

Figure g

Step 2: Patient depresses his right shoulder(a) and left shoulder (b).

Figure h

Step 3: Patient rotates his arm outwards, wrist in flexion (a) right; (b) left.

Step 4: Contralateral neck flexion with wrist flexed and elbow extended.

Figure i

Figure j

Step 5: Same as step 4, with arms slight elevated.

Pump water position: Pumping water position allows the non-painful arm to help guide mobilisation of the painful, injured arm. The starting position involves internal rotation of the shoulder.

Figure 11: Positioning for testing of radial nerve- pump water position.

ULNT(RADIAL): Sequential pattern includes

- Shoulder girdle depression
- Elbow extension
- Shoulder internal rotation and forearm pronation
- Wrist/ finger flexion
- Shoulder abduction
- Structural differentiation- cervical side bending, release shoulder girdle depression, release wrist flexion.

Figure 12: Positioning for ULNT for radial nerve.

Eligibility criteria

Inclusion criteria

- Radiating pain from cervical area to anterior aspect of forearm, arm till the metacarpals.
- Patients with carpal tunnel syndrome.
- NPRS value greater than 4.
- Patients having positive Spurling test, shoulder abduction test, valsalva manoeuver, neck distraction test and Elvey's ULTT tests.

Exclusion criteria

- Any red flags (eg. Tumor, malignancy, any signs of fractures in cervical spine, metabolic diseases, TOS).
- BP> 140/90 mm Hg, prolonged steroid use.
- Any systemic condition like Diabetes Mellitus, or neurological condition that altered functioning of nervous system.
- Any history of surgery, trauma, or pathology of upper back, hand.
- Patients on chemotherapy.
- Vertebro-basillar insufficiency.

Variables used in study

Independent Variables

- Nerve mobilization techniques.
- BPNT tests.

Dependent Variables

- Pain
- Cervical rotation range of motion.

Author	Patient Demographics	Intervention group (IG)	Comparison Group (CG)	Outcome	Results
Cleland., *et al.* (2007); A pilot clinical trial	N=11(7 male, 4 female); age range-21 to 45 years. Duration of symptoms= Greater than 5 weeks	4 patients with cervical radiculopathy- Neural stretching given (position hold for 20 seconds, 5 reps), HEP as ULTT for 2 times a day; dosage-hold for 20 seconds, 5 reps each	4 patients with Cervical radiculopathy given exercises like lateral flexion of neck and other isometric exercises (2 sets of 10 reps each, 3 times a day)	Outcomes were measured post treatment sessions: Using survey questionnaires. NDI scoring NPRS scale Body diagrams for symptom distrubution.	No significant baseline difference obtained between groups. Howver patients who received neural stretching approach or were taught showed significant improvement in the pain. The between-group comparison shows that ULTT as a part of HEP is better than isometrics.
Baysal., *et al.* (2006)	N = 5(3females, 2 male), 1 pregnant female in 2nd trimester, others with electrophysiological evidence of CTS, and bilateral presentation.	Group 1(N=2, 2 non- pregnant female and a male) both given custom made volar splint(worn for 3 weeks), also nerve and tendon gliding exercises taught-10 reps in 3 sets for a week). Group2= 1 pregnant female, 1 male- Neural gliding exercises taught along with Ultrasound(0.8W/cm2- to palmar carpal tunnel, 1mhz).	The only difference in intervention in both groups 1 and 2 is that group 1 used volar splint along with neurodynamic techniques whereas 2nd one received electrotherapeutic modality along with the neural techniques.	All measures were recorded in terms of Pain Tinel's sign Phalen's test. Hand grip strength 5. Pinch strength	Significant improved seen in 2nd group where along with neurodynamic exercises, a modality was also used. Patients reported significant strength after 3 weeks.

Coppieters., *et al.* (2003)	Mean age of patients -44.1(+/-12.1), having complaints of cervicogenic brachial pain; duration of symptoms >5 weeks	Neural tension provocation tests performed, then nerve sliding techniques taught, Self mobilisation with arm movement- mulligans approach taught)	Patients were given Ultrasound, dose = 0.5 W/cm2, 5mins duration, frequency = 1 MHz, Pulsed Ultrasound was chosen as it did not put stress on peripheral nerve.	Pain checked using VAS. Patient observed pre and post sessions.	There was significant improvement in terms of cervical rotation range of motion in groups receiving Mulligans mobilisation approach as compared to one only going for electrotherapeutic modality.

Table 2

Results and Discussion

Evidence sthesis

After reviewing several articles and going through RCT, all of them used different method of neural mobilization. As mentioned in the table, different set of interventions were given to the patients, however not all of them showed a positive result of neural mobilization approaches. There were also different kinds of neurodynamic dysfunction like CTS, cervical radiculopathy etc. So, overall there was a lot of heterogeneity which was seen in these searches.

Considering the literature searches and observations made in the patients, there seems to be an obvious paucity of research concerning the therapeutic use of neural mobilization as an established form of treatment for neurodynamic dysfunctions. As it has also been postulated that improvement in the mobility of the nerve may explain the perceived benefits of neural mobilization, it would be of some relevance if in future studies would be conducted making a comparison of clinical measures with that of neurodynamic approaches, like using real time diagnostic ultrasound and visualizing the movement of ulnar nerve for example while applying neural tension tests. Such kind of research would further give us the idea as to whether the neural mobilization approaches puts up a mechanical effect or neurophysiological effect on nervous system as a whole.

Conclusion

ABS-NM works as a therapeutic and diagnostic battery and proved active feedback to the individual from muscle contraction and movement.

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