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A Study to Evaluate the Effectiveness of Phenol Blocks to Peripheral Nerves in Reducing Spasticity in Patients with Paraplegia and Brain Injury

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Abstract

Primary objective: To evaluate effectiveness of phenol blocks of peripheral nerves in reducing spasticity brain injured and spinal cord injured patients.

Secondary objectives: To measure the change in the range of motion after phenol blocks to peripheral nerves, to identify the electrophysiological changes and to study the cost effectiveness and side effects of phenol blocks.

Study design: Descriptive study

Setting: Tertiary referral centre, India.

Methods: This study was conducted from March 2000 to January 2002 among 20 patients with spasticity. Spasticity was measured by modified Ashworth scale and range of motion was measured with a standard goniometer on 1st, 7th, 14th and 21st days of the study. Nerve conduction studies, gait analysis, and functional independence measure was measured on 1st and 21st day of the study. Nerve blocks were done on 7th and 14th day of the study with 0.5% bupivacaine and 6% phenol in water respectively.

Results: 20 patients were included in the study, out of which 85% had spinal cord injury and 15% patients had brain injury sequelae. Spasticity measured by modified Ashworth scale, showed a statistically significant reduction with neurolysis. Following obturator neurolysis abduction of hip joint improved significantly and with posterior tibial neurolysis there was significant improvement in dorsiflexion and plantar flexion range of the ankle joint. Functional improvement measured with the FIM score also showed statistically significant improvement after neurolysis. H reflex amplitude was significantly reduced following neurolysis. There was a statistically significant reduction in the consumption of systemic medications for spasticity following the injection.

Conclusion: Range of motion in neighboring joints improved significantly after blockade of spasticity using Phenol neurolysis. There was statistically significant reduction in the amplitude of the H reflex. There were no major adverse effects following neurolysis with phenol and it was found to be significantly cost effective when compared to systemic antispastic medications.

Key words : Phenol blocks, spasticity, spinal cord injury, H reflex.

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Introduction

Spasticity is a velocity dependant increase in tonic stretch reflex and exaggerated tendon jerk resulting from hyper excitability of the stretch reflex[1]. It is one of the most disabling aspects of brain and spinal cord injury. This needs to be treated if it interferes with activities of daily living, self care or when it causes discomfort or pain[2]. Common measures to control spasticity include passive stretching, serial casting, orthotics, medications, interventions such as nerve blocks, intrathecal blocks[3, 4], intrathecal medications, blockade of neuromuscular junction with botulinum toxin injections, surgical neurectomies[5] and tendon releases[6]. Many of these procedures are expensive and require a hospital set up to implement. Chemical neurolytic agent 6% phenol is a widely available drug which is inexpensive and has a wide margin of safety.

This study was undertaken to evaluate the effectiveness of phenol nerve blocks in the reduction of spasticity and to study the side effects and cost effectiveness when compared to orally administered systemic antispastic medications.

Materials and Methods

This study was conducted in the Department of Physical Medicine and Rehabilitation at a tertiary care teaching hospital during March 2000 to January 2002.

Inclusion criteria:

1. Patients who were observed to have disabling spasticity, at least 6 weeks after the onset of the lesion.

2. Spasticity in adductor group of muscles of the hip causing difficulty in performing activities of daily living or spasticity in the gastrosoleus group of muscles resulting in difficulty in walking or sitting in a wheelchair

Exclusion Criteria:

1.Comatosed patients.

2.Patients who could not give an informed consent, patients on anticoagulants,

3. Patients with renal calculi, vesical calculi, ingrowing toe nails, pressure ulcers, pneumonia or heterotopic ossification as these could cause increase in spasticity

This study was approved by the research committee of the institution and all patients were included in the study following an informed consent. They continued to have their rehabilitation programme depending on their medical condition. Department of Pharmacy of the institution provided ampoules of 6% phenol in water and 0.5% Bupivacaine. Bupivacaine was injected on day7 and 6% phenol in water was injected on day 14 of the study.

Measurements: Following measurements were done:
1. Spasticity was measured by modified Ashworth scale[7].

2. Range of motion was measured with a standard goniometer. Spasticity and range of motion were measured on days 1,7,14 and 21. On day 7 and day 14 spasticity and range of motion were measured one hour before and one hour after the intervention.

3. Electrophysiological parameters related to gastrosoleus: H reflex - latency, H reflex - amplitude, M wave – amplitude and H: M ratios were measured at the beginning and at the end of the study. Mystro + EMG/NCS machine was used for measurement.

4. The cost of antispastic medications that patient was taking through out the study period was recorded.

5. Any side effects following the injections were recorded.

6. Functional independence measure related to self care and locomotion was scored at the beginning and at the end of the study.

Technique of the nerve block: The nerves to be blocked were located using a needle electrode connected to an electrical nerve stimulator using a connecting wire wound around its base. The drug was injected to this nerve under strict aseptic precautions. The fibers intended for blockade was identified by stimulating the nerve. The intra neural topography of the fibers served as a guide during the stimulation[8]. For stimulation, a direct current lasting 0.05-0.1msec with a current strength of 3-5mA was used at the rate of 0.5-3Hz. Once the desired nerve was identified with minimal current, 3ml of solution was injected.

Obturator Nerve Block: With the patient supine and hip in maximum abduction, the adductor longus tendon was identified and the needle was directed posterior to the adductor longus muscle, approximately 3 cm below the pubic tubercle. To locate the posterior branch of the obturator nerve, needle was directed posteriorly from the adductor longus tendon towards the ischial tuberosity.

Posterior tibial Nerve Block: The patient was positioned in the prone position. The needle was inserted at a point 3 cm proximal to the popliteal crease lateral to the midline in the popliteal fossa.

Cost of antispastic medication

1. Tab Valium 5mg Rs.1/-

2. Tab Tizanidine 2mg Rs.7.50/-

3. Tab Baclofen 10mg Rs.10/-

Cost of injection phenol Rs.70/-

Results

Among the 20 patients included in this study, there were 18 males and 2 females. The spasticity was due to spinal cord injury in 17 patients, and following brain injury in 3 patients.

Spasticity was measured using modified Ashworth scale.

On day 1, Grade 3 spasticity was present in 16 patients and Grade 4 spasticity in 4 patients. After neurolysis with 0.5% Bupivacaine and 6% phenol respectively on 7th and 14th day, spasticity was reduced to Gr.0 in three patients and Gr.1 in 14 patients (p=0.00) (Table 1).

Day 1			
Mean	SD		
3.20	0.41		
Day 7			
Before Bupivacaine		**After Bupivacaine**	
Mean	SD	Mean	SD
3.20	0.41	0.25	0.44
Day 14			
Before Phenol		**After Phenol**	
Mean	SD	Mean	SD
3.20	0.41	0.80	0.52
Day 21			
Mean	SD		
0.80	0.52		
p-value: 0.000*			

Table 1: Spasticity as measured by Modified Ashworth score before and after Neurolysis (*statistically significant)

Range of motion: Thirteen patients had limited range of hip abduction because of adductor spasticity. After neurolysis of obturator nerve with 0.5% bupivacaine on 7th day, range of motion improved to twice the pre-injection range but reverted back to base line value within a week. After neurolysis with phenol on 14th day the abduction range doubled and this effect persisted on 21st day. These results were statistically significant with a p value of 0.00.

There was no change in hip flexion, extension and knee flexion range in these patients. Seven patients had limited dorsiflexion of ankle due to gastrosoleus spasticity. On the 7th day after neurolysis of posterior tibial nerve with 0.5% bupivacaine there was significant improvement in dorsiflexion of ankle but this effect did not last till 14th day. After neurolysis with phenol on 14th day, ankle dorsiflexion range improved again and this effect was persistent at 21st day (p=0.00). Ankle plantar flexion range also improved in these patients (p=0.002) (Table 2).

Functional Independence Measure: All patients included in this study were assessed for ADL independence which was measured with FIM. Feeding, grooming, bathing, toileting, upper-half dressing & lower-half dressing were measured as a part of self care activities. In locomotor activities, walking/wheel chair activities and stair climbing were measured. 9 patients were fully dependant in activities of daily living and 11 patients were partially dependant. All patients showed

Variable			**Hip F**	**Hip E**	**Hip Abd**	**Hip Add**	**Knee F**	**Ankle DF**	**Ankle PF**
Day 1		**Mean**	108	7.25	12.25	24	123.85	11.50	24.29
		SD	12.42	5.00	10.70	6.00	6.50	11.90	7.32
Day 7	**Before Bupivac**	**Mean**	108	7.25	12.25	24	123.85	11.50	24.29
		SD	12.42	5.00	10.75	5.98	6.50	11.82	7.32
	After Bupivac	**Mean**	108	7.25	31.50	25.50	123.85	23	34.29
		SD	12.40	5.00	5.87	6.86	6.50	8.01	7.87
Day 14	**Before Phenol**	**Mean**	108	7.25	12.25	24	123.85	11.50	24.29
		SD	12.42	5.00	10.10	5.98	6.50	11.10	7.32
	After Phenol	**Mean**	108	7.25	27	25.50	123.85	23	34.29
		SD	12.42	5.00	4.70	6.86	6.50	8.013	7.87
Day 21		**Mean**	11.0	7.25	27	25.5	123.85	23	34.29
		SD	14.31	4.99	4.70	8.63	6.50	8.01	7.87
p-value			0.33	1.11	0.00*	0.08	0.33	0.00*	0.002*

TABLE 2: Range of motion in hip and knees before and after neurolysis.

Abbreviations used in table: *statistically significant. F=Flexion, E=Extension, Abd=Abductors, Add=Adductors. DF=Dorsiflexion, PF=Plantar Flexion, Bupivac=Bupivacaine

significant improvement in self care and locomotion. Patients who received blocks to obturator nerve showed significant improvement in self care activities and patients who received posterior tibial blocks showed significant improvement in locomotion (p=.005) (Table 3).

Variables	Day 1		Day 21		P Value
	Mean	SD	Mean	SD	
Partial FIM Score	28.25	14.90	34.30	14.14	0.005*

Table 3: Modified FIM scores before and after neurolysis. *stastically significant

Electrophysiological Data: H-reflex latency, amplitude, M-wave amplitude and H: M ratios were measured on the 1st day and 21st days of the study. H- Reflex amplitude showed a significant decrease following phenol injections (p=0.04) but H: M ratio and H-reflex latency were not significantly changed on comparing the results with the t-test for paired samples. (Table 4)

Evaluation of cost of antispastic medication: All the patients who were included in the study were taking antispastic medications through out the study period. 4 patients were using a combination of oral Baclofen and Tizanidine, 6 patients were using a combination of Diazepam and Tizanidine, 7 patients were using only Tizanidine and 3 patients were using only Diazepam. Following nerve blocks there was reduction in consumption of systemic drugs in 9 patients, and there was a significant reduction in cost of medications (p=0.023) (Table 5).

Variables	Day 1		Day 21		P Value
	Mean	SD	Mean	SD	
H reflex (Latency) msec	28.62	8.10	229.88	3.90	0.48
H reflex amplitude (mv)	416.32	426.7	239.68	294.49	0.04*
M wave amplitude (mv)	6.90	5.53	9.64	18.73	0.57
H : M ratio	0.16	0.17	0.11	0.099	0.29

Table 4: Electrophysiological parameters before and after neurolysis

Variables	Day 1		Day 21		P Value
	Mean	SD	Mean	SD	
Cost of antispastic drugs	31.09	28.74	27.72	30.64	0.02*

Table 5: Cost of medicines used (in rupees) before and after neurolysis. *statistically significant

Side effects of Phenol: All patients were followed up until the end of the study to evaluate side effects for phenol blocks. No adverse effects as described in the literature were noted.

Discussion

Spasticity is one of the most disabling symptoms in patients with upper motor neuron syndromes like spinal cord injury and brain injury. It can cause pain and muscle shortening which is a major source of disability. The main goals of treatment are to reduce the deforming force as a result of spasticity, to improve function and prevent secondary complications due to spasticity.

Spasticity can be treated with physical modalities, oral medications, surgical methods and chemical neurolytic agents. Physical modalities commonly used are prolonged stretching, casting, orthotics, biofeedback and electrical stimulation. These physical methods are labour intensive and often provide only transient relief. The advantage of oral medications is that it can be used to reduce generalized spasticity but most of these medications are expensive. Side effects are common when these drugs are administered for long periods. A number of surgical procedures can be under taken for reducing spasticity but these procedures are expensive.

Chemical neurolytic agents like ethyl alcohol and phenol[9] are options for decreasing localized spasticity. Ethyl alcohol in higher concentration selectively denatures the proteins and injures cells by precipitating and dehydrating protoplasm[9]. It is easily available but its disadvantages include skin irritation, permanent peripheral nerve palsy and painful muscle necrosis. Neuromuscular junction blocking agents like Botulinum toxin[10] exerts a paralytic effect by rapidly and strongly binding to presynaptic cholinergic nerve terminals. It is very expensive and this often prevents use of this drug.

Phenol[11] (benzyl alcohol) is the major oxidized metabolite of benzene. Khalili[12] and colleagues performed perineural injections and Awad[13] pioneered intramuscular injections of phenol. Phenol when used for neurolysis denatures protein causing tissue necrosis. Wallerian degeneration occurs approximately 2 weeks following the injection and eventually there is re-growth of most of the axons. The duration of action of phenol blocks has been reported to be approximately 10-11 months using 2-3% Phenol. For the tibial nerve, Petrillo[14] et al showed an average of 13 months improvement using 5% phenol. Keenan et al[15] reported an average duration of improvement of 5 months

for Musculocutaneous7 nerve. Well controlled studies have in general reported an average duration of effect of phenol nerve block as 6 months.

In our study, 20 patients with spasticity following spinal cord injury or brain injury were treated with nerve blocks, either Obturator nerve block (13 patients) or Posterior tibial nerve blocks (7 patients), All of them showed significant but transient reduction of spasticity after the injection of 0.5% Bupivacaine on the 7th day of the study but there was a recurrence of spasticity as its effect was of short duration. After giving phenol nerve blocks on 14th day, reduction in spasticity was observed on the same day and this continued till the end of the study on the 21st day. From these results it is inferred that 0.5% Bupivacaine is a short acting agent whereas 6% phenol reduces spasticity for more than seven days. As spasticity decreased, there was definite improvement of range of motion in the neighboring joints. 13 patients showed consistent improvement in hip abduction range after giving bupivacaine injection and phenol injections to the Obturator nerve. The increased hip abduction range helped them in positioning, maintaining proper perineal hygiene and in self care activities like toileting and lower half dressing. It also helped in proper ambulation by decreasing the scissoring of the gait. The 7 patients who received injections to their Posterior tibial nerve showed significant improvement in dorsiflexion range which helped them in sitting, walking and climbing stairs.

Several standard physiological tests were used to assess spasticity of which H-reflex amplitude and H: M ratio have been shown to change in spasticity. Katz et al[16] showed increased H:M ratios in spasticity following spinal cord injury. In our study H amplitude was significantly diminished post phenol injection but H: M ratio was not significantly affected. H reflex amplitude can be used as an indicator of effectiveness of phenol block.

The common side effects of phenol blocks reported in literature are burning sensation and dysaesthesia. When phenol is injected into a vessel it can leads to thrombosis, ischemia and tissue sloughing. An overdose can cause tremors, central nervous system depression, and cardiovascular collapse. None of the patients included in our study group had any side effects as described in the literature.

Conclusions

Phenol block to peripheral nerves reduces spasticity in persons with spinal cord or brain injury. There was statistically significant improvement in range of movement in joints after nerve blockade using 6% phenol and 0.5% bupivacaine but the effect with bupivacaine was short lived. There was a reduction in H-reflex amplitude after the phenol blocks. Chemical neurolysis with phenol is a safe and cost effective method to reduce spasticity and to improve functions in patients with spinal cord injury and traumatic brain injury.

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