

# Effect Of Electrical Stimulation Following Hand Activities For Grasping In Incomplete Spinal Cord Injury:- A Case Report

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## ABSTRACT

**Background:** Spinal cord injury (SCI) is one of the most disastrous injury of the central nervous system which results in permanent neurological deficit. Typically, spinal cord injury occurs in young or healthy adults due to trauma. spinal cord injury occurs in between age group 16-30 years. Spinal cord injury is classified as acute or chronic, there is no clear separation as when to classify as acute injury and when it gets convert into chronic injury. The time period between initial hours and few weeks after injury is consider as acute phase, while the time period between months to years is considered as chronic phase. The clinical classification of these two phases is necessary as there is significant difference in these two and needs different strategies to manage and regain it's functional recovery

**Purpose:** Traumatic spinal cord injury (SCI) affects cervical spine in most of the cases. These causes limitation of activities of daily living and impairs quality of life due to paralysis of hand and arm. These leads to difficulties in feeding, grooming, or performing other upper extremity motor tasks. So in such cases the restoration of hand and arm functions is first priority of treatment before bladder, bowel, sexual or lower extremity dysfunction.<sup>[9]</sup> There are limited studies for improving hand function with help of electrical stimulation following motor function activities.

**Methodology:** A 41 year old male mesomorphic in built and farmer by occupation came to Pravara Rural Hospital, Loni, Ahmednagar with chief complaints of unable to move his both lower limbs and difficulty in his upper limb activity (grasping) . the patient had difficulty in basic activities of daily living. The patient had history of fall from tree. He was diagnosed with traumatic cervical spine injury with complete paraplegia and quadriparesis with bowel and bladder involvement. So the patient was operated on 11<sup>th</sup> July 2019 for cervical spine disectomy + fusion (C<sub>6</sub> – C<sub>7</sub>).

**Intervention:** The patient received Electrical stimulation following hand exercises for improvement in hand function for 5 days a week for 3 weeks.

**Result:** In this study we assessed the patient on action reach arm test (ARAT) for hand function, Functional Independence Measure for Quality of life (FIM), Spinal Cord Independence Measure (SCIM) which showed significant improvement in results.

**Conclusion:** it is concluded that electrical stimulation following hand function activities help in improving hand function in patients with spinal cord injury.

## INTRODUCTION

Spinal cord injury (SCI) is one of the most disastrous injury of the central nervous system which results in permanent neurological deficit. Typically, spinal cord injury occurs in young or healthy adults due to trauma. Spinal cord injury occurs in between age group 16-30 years.<sup>[1]</sup> The prevalence of SCI in India is around 0.15 million and average annual incidence is 15000<sup>[2]</sup> According to the study of Sekhon the leading causes of spinal cord injury are 40%-50% traffic crashes, 10%-25% work related injuries, 10%-25% injuries related to sport and recreational activities, 10%-25% acts of violence and 20% falls.<sup>[3]</sup> According to world health organization (WHO), the incidence of SCI is increasing in developing countries including India.<sup>[4]</sup>

Few decades back SCI patients used to die in short period of time due to limited emergency care available at the time of injury. Though their life expectancy today is increasing near to normal healthy individual yet the dependency for basic activity of daily living and managing things in day to day life remains for life.<sup>[1]</sup> The patients who have survive may get other associated medical conditions like urinary tract infections, decubitus ulcers, respiratory infections, cardiovascular diseases etc.<sup>[1]</sup>

Spinal cord injury is classified as acute or chronic, there is no clear separation as when to classify as acute injury and when it gets convert into chronic injury. The time period between initial hours and few weeks after injury is consider as acute phase, while the time period between months to years is considered as chronic phase. The clinical classification of these two phases is necessary as there is significant difference in these two and needs different strategies to manage and regain it's functional recovery.<sup>[1]</sup>

The spinal cord injury is classified into complete and incomplete spinal cord injury as it may influence the operative decision making such as removal of bone fragments that are compressing the spinal cord or decompression laminectomy. A complete injury is defined as an injury pattern in which there is absolutely no spine-mediated neurologic function below the level of injury. An incomplete spinal cord injury is defined as in which there is any function below the level of the injury, typically in the form of intact sensation (such as perineal) or slight distal motor function. The indication of incomplete injury which may show better prognosis for recovery of some degree of neurologic function is the sacral sparing which may allow some residual and sphincter function or sensation or slight movement of great toe.<sup>[5]</sup>

Injury can occur to any region of spine but the injury to cervical spine is the most sever one. It may just not cause the possible quadriplegia but also breathing can be impaired from neurological injury above C5. As compared to thoracic spine and lumbar spine less force is required to cervical spine to dislocate due to it's relative axial alignment of the facet joints, hence it is most vulnerable to injury. The external support to cervical spine is less as compared to thoracic spine which has support of rib cage for stabilization. Trauma to lumbar spine is less common and even if occurs results in root injuries, which are neurologically distinct from thoracic and cervical trauma<sup>[6]</sup>

The cervical spinal cord injury impacts directly on the functioning of upper extremities, although the trunk stability during upper extremity task and upper limb functioning also gets hampered to some

degree at thoracic level injury. Upper extremity plays the important role in patients activities of daily living and in quality of life.<sup>[7]</sup>

Any injury to the spinal cord hampers the communication between the brain and leads to varying levels of permanent paralysis. Regaining control of arm and hand is the biggest priority for people with paralysis more than restoring walking ability. The rehabilitation for the motor function after SCI is done by exercise therapy.<sup>[8]</sup>

There are some recent studies that shows that electrical stimulation can help in regain the conscious control of movement by activating the spinal cord circuits below an injury.<sup>[8]</sup>

Electrical stimulation help in maintain the integrity of various bodily functions through direct neuromuscular stimulation and in overcoming the deficit produced by the lesion in spinal cord.<sup>[1]</sup>

## NEED OF STUDY

Traumatic spinal cord injury (SCI) affects cervical spine in most of the cases. These causes limitation of activities of daily living and impairs quality of life due to paralysis of hand and arm. These leads to difficulties in feeding, grooming, or performing other upper extremity motor tasks. So in such cases the restoration of hand and arm functions is first priority of treatment before bladder, bowel, sexual or lower extremity dysfunction.<sup>[9]</sup> There are limited studies for improving hand function with help of electrical stimulation following motor function activities. Hence need of the study.

## METHODOLOGY

### HISTORY

A 41-year-old male mesomorphic in built and farmer by occupation came to Pravara Rural Hospital, Loni, Ahmednagar with chief complaints of unable to move his both lower limbs and difficulty in his upper limb activity (grasping). the patient had difficulty in basic activities of daily living.

The patient had history of fall from tree (height around 20 feet) on 3<sup>rd</sup> July 2019 in afternoon at akola, Patient was conscious and had no history of vomiting and was brought to hospital in Latur immediately by relatives in a car by neck supported. The complaint of patient in hospital was bilateral lower limb weakness, chest pain and neck pain. In latur he was diagnosed with traumatic cervical spine injury with complete paraplegia and quadriparesis with bowel and bladder involvement. So the patient was operated on 11<sup>th</sup> July 2019 for cervical spine disectomy + fusion (C<sub>6</sub> – C<sub>7</sub> ). And was admitted in ICU for few times. Later after discharge he was advised to start with physiotherapy treatment.

He started his physiotherapy treatment in ambejogai. During physiotherapy treatment he started feeling sensation in his bowel/bladder and his lower extremities. But during treatment he got bed sores so he had to stopped the physiotherapy treatment and got discharge from there. Later he went to another hospital in ambejogai for bedsore treatment and was admitted there for 2 and 1/2 months. After that he went to Aurangabad for acupuncture treatment but didn't get any more results. Later due to pandemic in 2020 his physiotherapy treatment was stopped and he was at home.

On investigations done in march 2021 for MRI (brain) showed no significant intra parenchymal abnormality seen and no findings. s/o acute intracranial hemorrhage / SOL. The cervical MRI showed spondylosis changes in form of perivertebral osteophytes and endplate marrow changes at plate and fusion of C<sub>6/7</sub> vertebrae.

Now in 2022 patient was admitted in Pravara Rural Hospital for physiotherapy treatment in Spinal Cord Injury Rehab for his treatment.

On Physiotherapy assessment we found the higher mental function, sensations, cranial nerve assessment was normal. Muscle tone on right side was 1+ and left side was 1 for upper extremity and for lower extremity it was 3 for both right and left side. Muscle power, range of motion, hand function was affected. Coordination, balance and posture could not be assessed. The patient had Ryles tube in-situ following debridement procedure... The patient had difficulty in performing hand functions like grasping objects and difficulty in holding it and was dependent on wheelchair for ambulation. He also had difficulty in wheelchair transfer due to difficulty in hand functions. Physiotherapy treatment was started which included bed mobility, trunk control exercises and active ROM exercises for upper and lower extremity and electrical stimulation for upper extremity.

**DIAGNOSIS**

Based on symptoms my patient Pratap agale is 41 years old male is case of traumatic spinal cord injury at C6 level with ASIA B.

**OUTCOME MEASURES**

Used to assess Hand function, Quality of life, -

1. Action Research Arm Test (ARAT)
2. Functional Independence Measure for Quality of life
3. Spinal Cord Independence Measure

**INTERVENTION**

<b>Duration of protocol</b>	<b>5 days /week For 3 weeks</b>
<b>Electrical stimulation</b>	Interrupted galvanic Duration:-30
<b>Sr no</b>	<b>EXERCISES</b>
1	Finger flexion ( making fist)
2	Tip to tip
3	Moving block to target line (4 different sizes blocks)
4	Moving large ball to target line
5	Moving small ball to target line
6	Theraputty balls
7	Finger theraband exercises
8	Moving pipes in target line (2 different size pipes)
9	Unscrewing the bottle
10	Placing coins in box

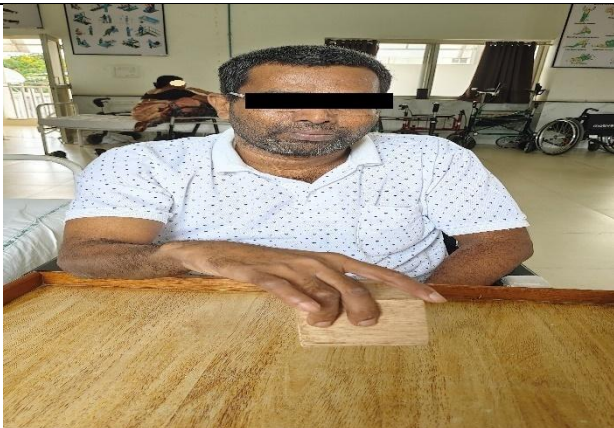




**ELECTRICAL STIMULATION APPLICATION**

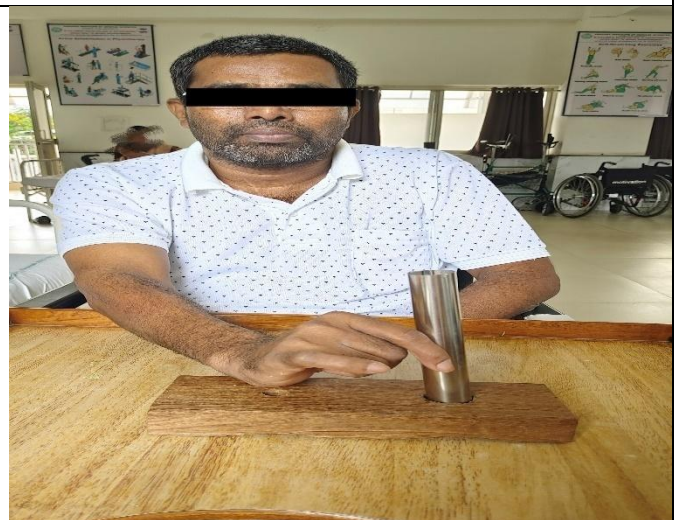
**PRE**

**POST**



**PATIENT GRASPING BLOCK**

**PATIENT GRASPING BLOCK**



**HOLDING A ALLOY TUBE**

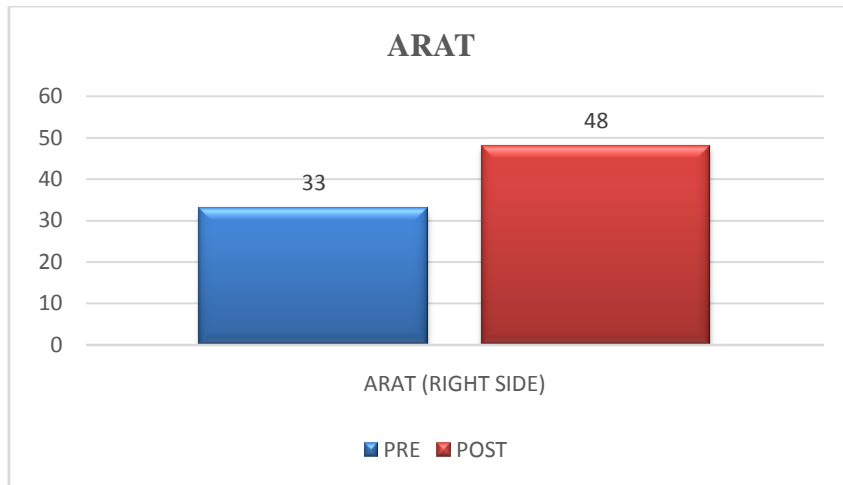
**HOLDING A ALLOY TUBE**

**RESULTS**

**Table 1: Assessment of pre and post scores for ACTION RESEARCH ARM TEST:**

Outcome measure	Pre (1 <sup>st</sup> week)	Post ( )
ARAT (right side)	33/57	48/57

**Graph no.1: Comparison of pre and post scores for ARAT**



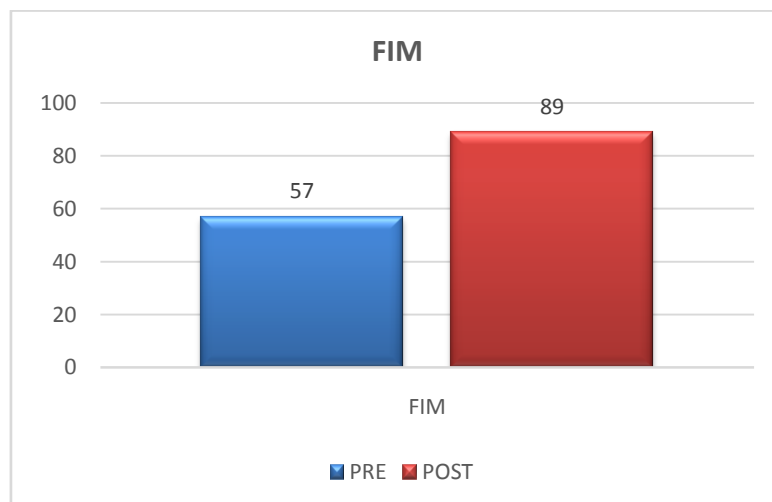
**Interpretation:**

The ARAT score for right side has been increased from 33/57 (moderate ability) to 48/57 (high ability). The functional ability of hand function has been significantly improved by the end of the treatment.

**Table 2: Assessment of pre and post scores for Functional independence measure:**

Outcome measure	PRE	POST
Functional independence measure	57/126	89/126

**Graph 2: Comparison of pre and post scores for Functional independence score:**

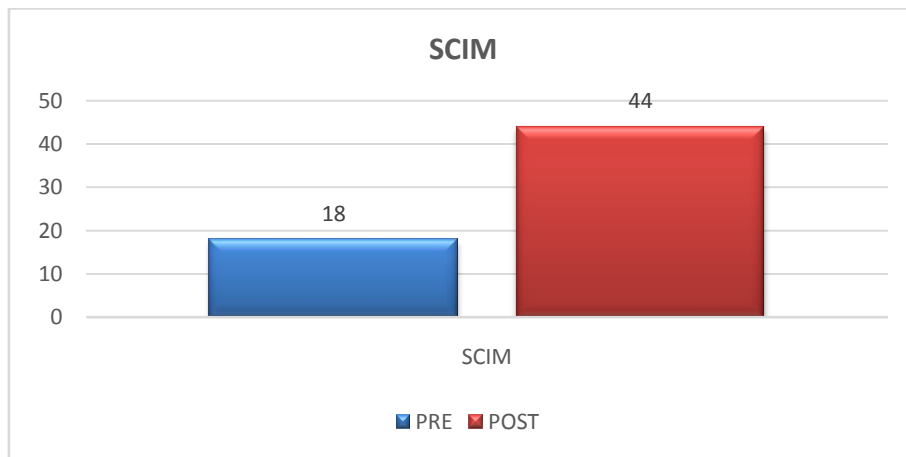


**Interpretation:** The Functional independence measure score increased from 57/126 pre treatment to 89/126 post treatment which showed the significant increased in functional independence in patient.

**Table 3: Assessment of pre and post scores for Spinal Cord Independence Measure:**

Outcome measure	PRE	POST
SCIM	18/100	44/100

**Graph 2: Comparison of pre and post scores for Spinal Cord Independence Measure:**



**Interpretation:** The score on spinal cord injury measure has been significantly improved from 18/100 pre treatment to 44/100 post treatment which indicates more independency in patient.

## DISCUSSION

In spinal cord injury various interventions have been studied in an attempt to improve arm and hand function in last few years.<sup>[10,11,12]</sup> In patients with spinal cord injury have seen that loss of arm and hand function is one the most devastating consequences of tetraplegia and it is the first priority of treatment in population. The need of improving the arm and hand function is necessary as it is important in daily activities, improving independence and quality of life.<sup>[10,14]</sup>

To improve motor function exercise therapy is the key player in rehabilitation.<sup>[8,14]</sup> There are some studies that have shown that electrical stimulation activates the spinal cord circuits below an injury to enable conscious control of movement. Vigorous exercise training helps in adapting and neuroplasticity.<sup>[15,16,17]</sup>

The exact process required for enhancing axonal regeneration in response to applied voltage gradient is not exactly known. The application of electrical field shows the axonal growth by being a mediated through membrane bound receptors and few secondary messengers such as adenylyl cyclase and interaction with other physiological neurotrophins present in central nervous system.<sup>[1,18,19]</sup> it is seen that there is reduction in the number of astrocytes within the injury site which leads to the changes to post-traumatic spinal cord blood flow.<sup>[18,20,21]</sup> electrical stimulation is seen to accelerate regeneration in peripheral nervous system and to enhance the expression of regeneration-associated genes (RAGs).

In this study we assessed the patient on action reach arm test (ARAT), Functional Independence Measure for Quality of life (FIM), Spinal Cord Independence Measure (SCIM) which showed significant improvement in results.

In systemic review by (Xiao Lu 2104) showed that six studies focused on the effect of exercise therapy these results showed that there is improvement in muscle strength and upper limb/ hand function. In the one of the studies there is improvement in activities of daily living measures by functional independence measure and quadriplegia index of function. In this review there they reviewed four studies which studied the effect of electrical stimulation which focused on the change in upper limb strength. Few studies showed changes in wrist extensors strength and showed significant improvement after electrical stimulation (ES) therapy. <sup>[10]</sup>

## CONCLUSION

From the results of this study, it can be concluded that electrical stimulation with hand function activities help in improving hand function in patients with spinal cord injury.

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