

# Intrathecal Baclofen: Our Experience in Neuromodulation of Spasticity in Traumatic Spinal Cord Injury Patients

Kumar S<sup>1</sup>, Maheshwari V<sup>2</sup>, Dey S<sup>3</sup>, Pandey R<sup>4</sup>

<sup>1</sup>MCh Neurosurgery, Col (Dr) Sanjay Kumar, Associate Professor, Department of Neurosurgery, Command Hospital (Southern Command), Pune, India – 411040

<sup>2</sup>MCh Neurosurgery, G P Capt (Dr) Vikas Maheshwari, Professor, Department of Neurosurgery, Command Hospital (Air Force), Bengaluru

<sup>3</sup> MCh Neurosurgery, Col Subir Dey Assistant Professor, Department of Neurosurgery, Command Hospital (Southern Command), Pune, India - 411040

<sup>4</sup>SR Neurosurgery. Dr Rohit Pandey, Department of Neurosurgery, Command Hospital (Southern Command), Pune, Maharashtra, India – 411040

**Abstract:** ***Aims & Objective:** Spasticity develops invariably over the period of few months in patients of spinal cord injury (SCI). The subgroup of patients who become ambulant after the rehabilitation period are severely disabled after the development of spasticity and may become bed bound. Our aim was to describe the use of intrathecal baclofen therapy with implantation of baclofen pump in improving the QoL. **Material and Methods:** Ours is a referral centre of Indian Armed Forces for the comprehensive management of patients sustaining traumatic SCI. 5 patients of traumatic spinal cord injury who developed disabling spasticity and underwent baclofen pump implantation for intrathecal delivery of baclofen after failure of oral medications were included in this study. The period of study was Jan 2017 to Jun 2019. All the 5 patients had modified Ashworth grade 4 spasticity at the time of the implantation of the device. **Results:** All 5 patients had significant improvement for the spasticity and became ambulant again which was hampered by the development of severe spasticity. 1 patient had transient hypotension lasting for 7 days which resolved spontaneously without any intervention. 1 patient developed implant related infection which was initially managed with antibiotics but eventually required removal of the implanted device. During the follow up period (5 – 27 months) good control of spasticity has been maintained in the 4 patients with improvement on overall QoL. **Conclusions:** ITB delivery through implantation of delivery device is a definitive option in patients of SCI who develop disabling spasticity restricting the patient's mobility and affecting overall QoL. The most important advantage of this modality is that it is a reversible procedure and drug delivery dosage can be titrated according to patients requirement, which is not possible in patient undergoing DREZotomy. The complication related to the drug/device is few and can be managed adequately.*

**Keywords:** Intrathecal baclofen, Spinal Cord Injury, Drezotomy, Spasticity

## 1. Introduction

Spinal Cord Injury (SCI) is one of the most debilitating neurological conditions which mainly affects the young and middle age individuals [1, 2] who still have a long life ahead. SCI is a devastating condition which occurs with an annual incidence of 12.1-57.8 cases per million [3] Although more than 80% of the world's population live in the more than 100 developing countries, little information is available regarding the epidemiology of SCI in these countries [4]. Motor Vehicle accidents (MVA) are the main aetiology of SCI and in India has been reported to 30.3 to 34.8 % of all patients sustaining SCI [5, 6]. The annual incidence of SCI reported in literature developed countries is 13.1 to 163.4 per million people. [7, 8] and developing countries varied from 13.0 to 220.0 per million people [8, 9]. The initial management of patients sustaining SCI entails early decompression of the neural structures along with stabilisation of the spine with instrumentation for optimal neurological recovery in these patients. The functional neurological recovery in patients of SCI depends on multiple factors like severity of injury, degree of neurological compromise, initial neurological status of the patient at the time of presentation, timing of surgery, adequacy of surgery with optimal neural decompression and stabilisation of

spine, associated injuries like limb fractures, lung and abdominal injuries, introduction of early physical rehabilitative measures and so on. Patients with SCI are best managed at specialised centres having a team of Neurosurgeons, Neurologist, Neuropsychiatrist, Orthopaedic Surgeon, Physiotherapist, paramedical staff trained specifically in management of these patients and Vocational rehabilitation specialists for optimum outcome in improving the quality of life (QoL).

Patients with SCI in the later period suffer from multiple associated problems like intractable pain, spasticity of the limbs, muscle contractures, joint deformities, myositis ossificans wasting of muscles, pressure sores, psychiatric disturbances, suicidal thoughts and so on. Some of these problems are directly a result of the SCI per se whereas a few of them are secondary to the consequences of the SCI.

Spasticity is one such entity which affects almost all patients with SCI irrespective of the level of injury and it affects the QoL in these patients. Spasticity has been defined as "disordered sensorimotor control resulting from an upper motor neuron (UMN) lesion, presenting as intermittent or sustained involuntary activation of muscles.[10] The timing of onset of spasticity is variable in patients of SCI although

maximum intensity is noted over several months in most of the patients[11]. Flexor spasms occur earlier whereas extensor spasms occur later in patients of SCI to varying degrees [12, 13] Objective assessment of spasticity is done by modified Ashworth grading system. There are two broad groups of patients of SCI, one group is those patients who are not independently ambulant and either bed bound or wheel chair bound whereas the second group is of those patients who are ambulant with/without support. The current modalities available for management of spasticity are – medical management, Botulin toxin injections, intrathecal baclofen therapy, drezotomy, etc. [14]. The modality to be used for spasticity management in patients with SCI has to be individualised depending on the need of the patients and to improve the overall QoL.

Ours is one of the largest centre in India involved in the comprehensive management of patients of SCI from the Indian Armed Forces. Most of our patients are relatively young as expected due to younger individuals being enrolled in the Armed Forces and different job profile as compared to civilian population. The cost of any therapy we chose is also guiding principle in management of spasticity due to limited resources at our disposal. The first group of patients with no adequate functional locomotion ability are generally managed by DREZotomy [15] to alleviate the spasticity with or without flexor/extensor spasms for overall QoL.[15] The second group of SCI patients who were previously ambulant with/without support and have lost this ability because of the spasticity are managed with intrathecal baclofen therapy to alleviate the spasticity so that this subgroup of patients again become ambulant with/without support. We report our experience of management of spasticity in 5 patients from the second subgroup of patients delivered intrathecal baclofen through baclofen pump.

## 2. Material and Methods

Five patients of SCI who underwent baclofen pump implantation during the period of Jan 2017 to Jun 2019 were included in this study. The demographic profile, time of injury, level of injury, and ASIA score at the time of injury are as per table 1.

**Table 1:** Demographic profile and epidemiology of patients included in this study

Patient's detail	Age (yrs)/Sex	Date of injury	Mode of injury	Level of injury	ASIA score at the time of injury
Patient 1	23/Male	Jan 2017	Fall from height	DV8	A
Patient 2	29/Male	June 2017	MVA	DV9	A
Patient 3	31/Male	Nov 2017	Fall from height	LV1	B
Patient 4	18/Male	Aug 2018	MVA	DV11	A
Patient 5	25/Male	Jan 2019	MVA	DV10	A

All the patients had sustained traumatic vertebral fracture with significant neural compromise. Management of these patients was as per the TLICS guidelines and underwent early neural decompression with spinal stabilisation surgery using instrumentation as mentioned in table 2.

**Table 2:** Details of the procedure carried out in the patients of SCI included in the study

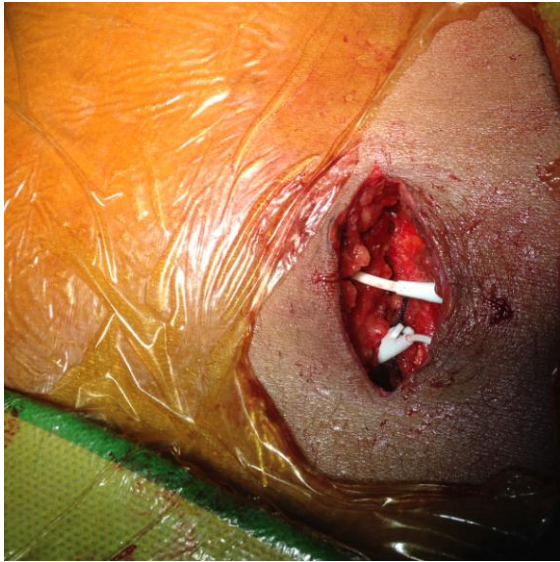
Patient	Timing of intervention	Intervention done
Patient 1	Same day of injury	Corpectomy DV8, expandable cage placement
Patient 2	2 days after injury	Laminectomy DV8 & 9, pedicle screw fixation DV6 – DV11
Patient 3	7 days after injury	Corpectomy LV1 + expandable cage placement
Patient 4	Same day of injury	Corpectomy DV11 + expandable cage placement
Patient 5	4 days after injury	Corpectomy DV10 + expandable cage placement

In the post-operative the patient were initiated on extensive physical rehabilitation as per the protocol at our centre and bowel and bladder training. 3 out of the 5 patients became ambulant with support after a period mean duration of 6 months whereas 2 of the patients reached the same status after 9 months of rehabilitation. The mean time after which the patient started developing spasticity was 3.5 months and all these patients developed grade 4 spasticity according to modified Ashworth scoring system 11 months (mean) after the date of injury.

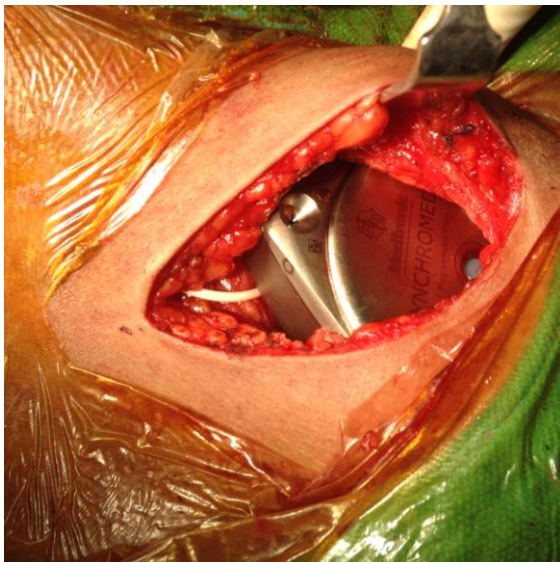
During the period of first onset of spasticity and till these patients were considered for implantations of baclofen for intrathecal therapy were managed with standard protocol of spasticity management.

At the time of implantation of the baclofen all five patients had become non-ambulant due to the severe spasticity affecting the limbs and had become bedbound/wheelchair bound. 2 out of the 5 patients also had intractable pain involving the lower limbs.

Once the decision of intrathecal baclofen pump implantation was taken, all these patients underwent preoperative evaluation as per our institutional protocol. Test dose of intrathecal baclofen was administered according to existing protocol for evaluation of efficacy of the drug before they were taken for the definitive procedure. The response of the test dose of intrathecal baclofen on spasticity was noted down in all 5 patients. Implantation of the hardware was done as per the existing protocol. The intrathecal catheter was placed percutaneously in 3 patients and through open approach in 2 patients through the LV3/4 space (Image 1, & 2) and guided to reach DV12 vertebral level.



**Image 1:** Shows the site of insertion of the delivery catheter in thecal sac



**Image 2:** Shows the baclofen reservoir with connecting catheter in subcutaneous pouch in left iliac fossa

The other end of the catheter was tunnelled subcutaneously and connected to the drug delivery device which was implanted in a subcutaneous pouch in the left iliac fossa in all 5 patients. The infusion rate was started at 25 micrograms initially after the surgery and subsequently titrated to achieve optimal response to the spasticity (table 3).

Patient	Initial rate of infusion	Time taken to achieve optimal control	Maximum rate of baclofen infusion
Patient 1	25	08 weeks	50
Patient 2	25	5 weeks	75
Patient 3	25	7 weeks	75
Patient 4	25	11 weeks	50
Patient 5	25	3 weeks	75

Table 3: Shows the time taken post-operatively and maximum rate of baclofen infusion to achieve optimal control.

The response was monitored at regular interval and the oral drugs were withdrawn in a phased manner over a period of

one month by time optimal rate of infusion of intrathecal baclofen was achieved. The infusion rate of intrathecal baclofen was titrated in a manner that some degree of spasticity was maintained which helps in the motor function of patients. Neurological status was assessed 3 months after the procedure by which time all patients had again become ambulant with/without support as they were earlier before severe spasticity had confined them to bed/wheel chair. Immediate post-operative and delayed complications noticed are as outlined in table 4.

**Table 4:** Complications seen in our cohort of patients.

Complication	No of patients
Transient hypotension	1
Displacement of intrathecal catheter	Nil
Fracture of catheter	Nil
Pump failure	Nil
Superficial wound infection	Nil
Deep site infection	1

1 of the 5 patients had transitory hypotension in the immediate post-operative period which resolved after 3 days spontaneously. One patient had developed hardware related complication in the form of features of infection in the subcutaneous pouch in left iliac fossa. 3 months after the initial surgery Initially this patient was managed with injectable antibiotics for 15 days, however infection persisted and the hardware was removed surgically and patient was restarted on oral medications for management of spasticity.

### 3. Results

The level of injury was lower dorsal spine in 4 patients whereas in 1 patient it was at LV1. 4 patients had undergone corpectomy of the fractured vertebra causing canal compromise followed by expandable cage placement and screw and rod fixation within 5 days of the injury. 1 patient had undergone laminectomy for neural decompression followed by pedicle screw and rod fixation. All the 5 patients had spinal cord injury at the time of accident. The follow up MRI done before the intervention showed thinning of the cord with myelomalacic changes in the spinal cord at the level of injury in all 5 patients. All the 5 patients who were included in this study had modified Ashworth grade 4 spasticity at the time of implantation of intrathecal baclofen delivery pump. These patients had reached the grade 4 spasticity after mean period of 8.5 months after the time of sustaining the SCI.

All 5 patients were on maximum dose of drugs for management of their spasticity and in spite of that they had modified Ashworth grade 4 spasticity. The five patients were ambulant after the injury with/without support 5.5 months (mean) after the injury however became bed bound due to severe spasticity. After evaluation of all 5 patients as per our institutional protocol, they underwent baclofen pump implantation for intrathecal delivery. The patients were started on infusion rate of 25 micrograms in the immediate post-operative period (1<sup>st</sup> post op -day). One patient had transient hypotension in the post-operative period which resolves within 7 days post-surgery. There were no other procedure related / implant related complications in the

immediate post-operative period. All the patients were further reviewed as per our institutional protocol. The infusion rate of was adjusted during OPD visits to achieve optimum result. 2 patients stabilised with grade 1 spasticity at 50 micrograms and 3 patients required infusion rate of 75 micrograms to achieve the optimum result. All five patients became ambulant with/without support as they were earlier before the onset of disabling spasticity. 1 patient developed features of infection at the site of pump implantation in the left iliac fossa. He was initially treated empirically with intravenous antibiotics for 02 weeks followed by four weeks of oral antibiotics. However after an initial period of infection subsiding with antibiotics he again developed features of infection at the hardware was removed after 7 months of initial therapy.

Hence from the outcome it is seen that this procedure is a safe and helps to a great extent in providing relief to patients of SCI who develop disabling spasticity affecting there QoL.

#### 4. Discussion

The aim of treatments for spasticity is to improve the range of motion, mobility, facilitating the caregivers helping the patients in ADL, preventing muscle contractures and achieving self-care and independence. The management of spasticity is broadly divided into medical and surgical therapies. The medical therapies include drugs like baclofen, tizanidine, diazepam, gabapentin etc. Surgical therapies intrathecal baclofen delivery devices & DREZotomy. Local infiltration of botulin is also a valuable therapy but has short term effect only.

ITB for spasticity was first described in 1985.[16] Since then, there have been numerous published studies demonstrating its efficacy in the treatment of spasticity, spasm related pain and improved quality of life in patients with spasticity of spinal and supraspinal origins [17, 18, 19].

Intrathecal drug delivery (ITDD) facilitates the direct administration of drugs at a site of action, which allows for the use of lower doses of the drugs, thereby reducing their side effects while achieving maximum therapeutic benefit. Intrathecal baclofen (ITB) therapy is an effective alternative for the management of spasticity in patients in whom other treatment options (pharmacological agents, non-pharmacological adjuvants) have failed to provide adequate relief of symptoms, or for patients who derive benefit from oral or systemic medications but for whom the side effects have become intolerable.

A prospective multicentre ITB case series with a 3-year follow-up in 64 patients with spasticity of spinal origin identified a decrease in the Ashworth scale greater than two points and a reduction in spasm score [20].

One of the main reasons for hesitation in using ITB in ambulant individuals with spasticity is that the individuals often make use of their extensor spasticity to bear weight for transfers, standing, or even walking [21, 22, 23].

Intrathecal delivery of baclofen pump is a significant improvement over earlier measures in improving the

disabling spasticity in patients of SCI. The most important advantage of this modality for management of spasticity is that the rate of delivery of baclofen can be controlled to achieve the optimum relief in patients. The subgroup of patients who have become ambulant with/without support and subsequently become bedbound due to development of spasticity are maximally benefited from this modality. SCI injury patients require some degree of spasticity which helps them in walking. This ITB achieves this state of balance in the spasticity because the rate of infusion can be controlled as was achieved in our 5 patients. The control of spasticity was maintained for all 5 patients during the period of follow up which ranged from 9 months to 26 months.

Complications of ITB are usually directly related to 1 or more issues involving the surgical implantation procedure, mechanical failure of catheter/pump devices, and issues with the baclofen drug therapy, including withdrawal and overdose. The overall complications arte varied from 0 – 2.24 per implantation across various studies [24].

ITB therapy is a beneficial adjunct in patients of SCI who have achieved mobility through extensive physical rehabilitation and become bed bound due to the problems because of severe spasticity. The most important advantage is the rate of infusion of baclofen can be titrated to achieve a balance between disabling spasticity and the minimum tone required for ambulation in this particular subgroup of patients as was achieved in our cohort of patients. This overall improves QoL in these patients. The initial cost of the hardware implantation can be a deterrent but if analysed over a long term period vis a vis oral medications required to treat the spasticity is balanced out. The minor complication of transient hypotension are transient and resolve over a short period of time.

#### 5. Conclusion

Development of disabling spasticity in patients of SCI is a major problem affecting the QoL in these patients by hampering locomotion and affecting ADL. A subset of patients become non-responsive to the oral medications used to treat the spasticity. ITB therapy through implantation of a continuous delivery is a safe and useful alternative modality to treat spasticity. The most important aspect is fewer side effects and rate of infusion of baclofen can be controlled to achieve the optimum relief in each patients.

The initial cost of the hardware implantation may be a limiting factor but if analysed over a long term period the financial implications is not a major issue. The relatively ease of refilling the chamber with baclofen as and when required is another benefit. Hardware related complications are same as for any other implanted devices and do not have a significant morbidity/mortality.

#### 6. Conflict of Interest

None

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