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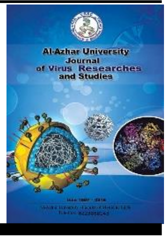

Outcome of Selective Dorsal Rhizotomy in Management of Spasticity

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Abstract

According to medical literature, spasticity is described as "disordered sensorimotor control arising from a UMN lesion." Nevertheless, spasticity is seldom seen on its own and is typically accompanied by other symptoms of the UMN syndrome. SDR is the main weapon in his or her arsenal. To assess the outcome of selective dorsal rhizotomy in the management of spastic patients and its degree. The research was conducted at the Department of Neurosurgery at Al-Zahraa Hospital and health insurance hospitals on 20 patients. Most cases (60%) had Ashworth scale 3, significantly higher than scale 1. Regarding gait classification, most of the cases (60%) had GMFCS scale 3, significantly higher than scale 1. Regarding causes of spasticity, most of the cases (90%) had CP, significantly higher than cases with spinal injury. Postoperative status was improved significantly in 60 % of cases. Back pain was significantly the most common complication in comparison to other complications. This study concluded that selective dorsal rhizotomy may be a good and safe option for the treatment of spasticity and may improve the condition of the spasticity among patients.

Keywords: Dorsal Rhizotomy, Spasticity, Upper motor neuron (UMN).

1. Introduction

Spasticity is defined as ‘disordered sensorimotor control resulting from an upper motor neuron (UMN) lesion, presenting as intermittent or sustained involuntary activation of muscles **[1].**

According to this concept, spasticity is not only a motor problem but also a dysfunction of sensorimotor control. Additionally, it shows that spasticity manifests as muscular overactivity rather than just as stretch reflex hyperexcitability, which has significant ramifications for therapy, which was subsequently oriented toward minimizing muscle overactivity **[2].**

Spasticity varies from being a clinical sign with no functional impact to being a gross increase in tone interfering with mobility, transfers and personal care. Untreated, it can cause shortening of muscles and tendons, leading to contractures. Some patients depend on their spasticity to stand, walk and transfer or sit upright. The optimum management of spasticity requires a coordinated approach with rehabilitation professionals [**3].**

Spasticity makes people need more care and use more healthcare resources. Patients with spasticity may learn to control it and utilize it to help them sit, stand, walk, or transfer. It is important to strike a balance while managing spasticity, considering both the potential advantages of therapy and the value of the spasticity itself [**4].**

While hyperreflexia is an essential component in identifying spasticity, several investigations have revealed that individuals with "spasticity" exhibit resistance to movement that is not connected to reflexes [**2].** In addition, although hyperreflexia is elicited relatively early after injury, the resistance to passive movement measured using the Modified Ashworth Scale (MAS), which is commonly used to assess spasticity clinically, has a tendency to increase in prevalence over the subsequent weeks and months [**5].**

This is true even though hyperreflexia is elicited relatively early after injury. Even modest hyperreflexia early on is a significant predictor of severe spasticity and greater resistance to passive movement later [**6**]. This suggests that hyperreflexia may be the trigger for a cascade of processes that lead to a buildup in the resistance to movement.

This procedure involves a surgical section of dorsal nerve roots of the lumbosacral spinal cord. This reduces the sensory input into spinal motor neuron pools, reducing their excitability. It is usually used to treat spasticity associated with cerebral palsy, with good long-term outcomes [**7**].

2. Patients and Methods

This study was conducted as a prospective randomized interventional study in the period from Feb.2022 to Mar.2023.

The study was carried out at the Department of Neurosurgery at Al-Zahraa Hospital and health insurance hospitals.

Children and Adults presented to the outpatient clinic of the neurosurgery department at Al-Zahraa Hospital and health insurance hospitals with spasticity. Twenty patients were recruited for this study.

2.1 Inclusion criteria

All Age groups, Both sexes, Ambulant spastic patients, Different causes of spasticity and Intact sensory functions.

2.2 Exclusion criteria

Spastic patients with sensory affection, Bed ridden spastic patients and Spastic patients with comorbidities that affect peripheral nerves.

2.3 Ethical consideration

Surgical consent was acquired from patients and their relatives with explanation of potential benefits and complications before the start of the study.

2.4 Study tools and procedures

All patients were submitted to the following: History and clinical examination (Personal, Present, Past and family history, General examination and Local examination) and investigations (Full laboratory investigations and Imaging procedure radiological diagnosis (MRI lumbosacral spine)).

2.5 Surgical management by SDR

Anesthesia, Position and EMG electrodes insertion, Postoperative Care, Postoperative course and Ethical considerations. Anaesthesia was induced with sevoflurane and was maintained with fentanyl and sevoflurane. Propofol was avoided because it alters EMG activities. The patient receives a dose of antibiotics before a skin incision. A bladder catheter was inserted.

2.6 Surgical procedure

Proper localization of skin incision preoperatively was determined using C-Arm if possible, planning to expose the level of lumbar spine needed to be operated on. Meticulous sterilization to be applied to decrease risk of infection as possible, then draping. Skin incision was done, followed by muscle separation taking in consideration avoidance of excessive bleeding and very meticulous hemostasis.

A laminectomy or laminoplasty was performed to expose the entire dura containing the whole cauda equine. After bleeding from the epidural veins and bone was controlled, a dural incision was made. Saline irrigation is not used after the dura is opened because it alters EMG responses. An operating microscope was then brought into the field and used during EMG testing and sectioning of dorsal rootlets. At this point, EMG activities are continuously monitored to determine if any movement of the nerve roots evokes EMG activities. Stretching and pressure on the ventral roots but not on the dorsal roots evoke EMG activities and often the movement of the patient's lower extremity. Next, spinal roots (needed to be cut) were identified at the neural foramen, and the dorsal root is separated from the ventral root using EMG monitor findings (as the ventral roots gives EMG findings) and after bleeding from the epidural veins and bone was controlled, a dural incision was made. Saline irrigation is not used after the dura is opened because it alters EMG responses. An operating microscope was then brought into the field and used during EMG testing and sectioning of dorsal rootlets. After the innervation of a dorsal root is determined, the root is sharply subdivided into three to five smaller rootlets of equal size. The rootlet fascicles are suspended over two hooks of the rhizotomy probes, then, application of stimulation with 50 Hz frequency and 3 mA to each rootlet. Most rootlets produce +1 to +4 responses. Thus, we base our decision to section a given rootlet on the number of rootlets producing sustained responses at that level and the intensity of the responses. The rootlets that produce a response of 0 are left intact. The rootlets producing +3 and +4 responses are cut, and those producing +1 and +2 responses are sometimes spared. At least one rootlet was left irrespective of EMG responses to avoid postoperative sensory loss. The intradural space is irrigated with saline solution. Bipolar cautery was required for control of bleeding from the cut ends of rootlets. The dura was closed in a watertight manner, if laminoplasty was done, the removed bones were to be put back, then proper layered closure of the incision.

3. Results

Twenty spastic individuals were enrolled in the research group. The mean age of patients was 21.9 ± 16.5 years and ranged from 3 to 40 years as shown in Table .1. There was no significant difference regarding limb affection between hemispastic (30%), paraspastic (25%), quadrispastic (20%) and diplegic (25%) (P.>0.05) as shown in Table. 2. Regarding causes of spasticity, most of the cases (90%) had CP, significantly higher than cases with spinal injury (10%) (P <0.05) as shown in Table .3. Most of the cases (60%) had Ashworth scale 3, significantly higher than scale 1 (5%), scale 2 (30%), and scale 4 (5%) (P= 0.0009) as shown in Table .4. Regarding gait classification, most of cases (60%) had GMFCS scale 3, significantly higher than scale 1 (5%), scale 2 (25%), scale 4 (5%), and scale 5 (5%) (P.<0.05) as shown in Table .5.

Postoperative status was improved significantly in 60 % of cases, while 30% of cases remained as preoperative status, and 10% deteriorated (P= 0.0224). Back pain was significantly the most common complication (85%), in comparison to other complications (P.<0.05), while CSF leak, paraplegia, and wound infection were significantly absent in 75%, 90%, 80% of cases respectively (P.<0.05) as shown in Table .6.

Table (1): Age of the study group (n=20).

Age (y)	Study group (n=20)
Mean ± SD	12.1 ± 9.01
Range	3 – 40

Table (2): Site of affection in the study group (n=20).

Cranial nerve affection	Study group (n=20)	P. value	
	N	**%**	
Normal	**12**	**60**	0.3711
Affected	**8**	**40**	
Facial palsy	3	37.5	0.4169
Bulbar	4	50	
Loss of hearing	1	12.5	
Limb affection	**N**	**%**	
Hemi spastic	6	30	0.9402
Para spastic	5	25	
Quadri spastic	4	20	
Diplegic spastic	5	25	

***P ≤ 0.05 is considered significant**

Table (3): Cause of spasticity.

Cause of spasticity	**Study group** (n=20)	
	N	**%**
CP	18	90
Spinal	2	10
Chi-square	12.800	
P. value	0.0003*	

***P ≤ 0.05 is considered significant**

Table (4): Ashworth Scale classification of the study group.

Ashworth Scale	**Study group** (n=20)	
	N	**%**
1	1	5
2	6	30
3	12	60
4	1	5
Chi-square	16.400	
P. value	0.0009*	

***P ≤ 0.05 is considered significant**

Table (5): Ashworth Scale classification of the study group.

GMFCS scale	**Study group** (n=20)	
	N	**%**
1	1	5
2	5	25
3	12	60
4	1	5
5	1	5
Chi-square	23	
P. value	0.0001*	

***P ≤ 0.05 is considered significant**

Table (6): Postoperative status and complications of the study group.

Postoperative status	**Study group** (n=20)		**p. Value**
	N	**%**	
Improved	12	60	0.0224*
As preoperative	6	30	
Deteriorated	2	10	

Postoperative complications					
Back pain	17	85	3	15	0.0017*
Transient urinary incontinence	8	40	12	60	0.3711
CSF leak	5	25	15	75	0.0253*
Paraplegia	2	10	18	90	0.0003*
Wound infection	4	20	16	80	0.0073*
Sensory affection	7	35	13	65	0.1797
P. value	< 0.0001*		< 0.0001*		---

***P ≤ 0.05 is considered significant**

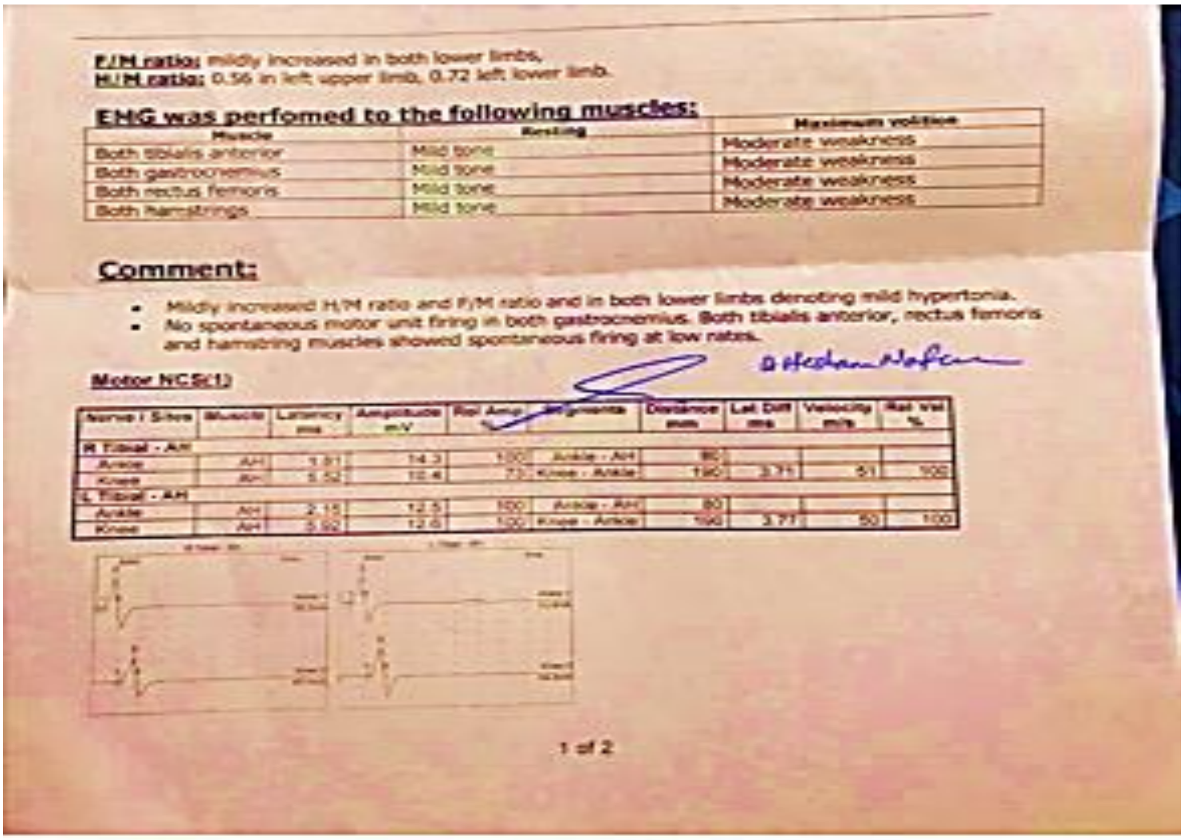
3.2 Case presentation

Case 1: 5yrs old girl, 1st order of birth of uneventful perinatal period of CS delivery on top of preterm labor at 7 months gestation of NICU admission immediately postnatally for prematurity for 2 weeks then readmitted again after that by one month for haemoglobin drop and hypoxia for one week, of nonconsanguineous parents, Parents noticed that delayed independent sitting and support of head and neck till 9 months of age. Also, parents notice inability to stand and walk till 18 months of age after which they sought medical advice and physical therapy is done after which she can walk independently. On examination Patient was fully conscious, paraparetic G4+, hyper-tonia, hyper-reflexia G3+, Scissoring gait and talipes equino varus foot, Modified Ashworth scale 3, GMFCS level 4.

3.3 Operative care

The patient was transferred to the ward, took proper antibiotics and analgesics and after two days started static physiotherapy the patient showed a mild temporary decline in bilateral hamstring and calf muscles motor power with transient urinary incontinence with moderate low back pain, all improved with short course of anti-inflammatory medications. patient on a follow-up course showed improvement in hypertonia and functional response of both lower limbs.

Figure (1): Preoperative antero-posterior Pelvic X-ray.



F/M ratio: mildly increased in both lower limbs.
H/M ratio: 0.56 in left upper limb, 0.72 left lower limb.

EMG was perfomed to the following muscles:

Muscle	Resting	Maximum volition
Both tibialis anterior	Mild tone	Moderate weakness
Both gastrocnemius	Mild tone	Moderate weakness
Both rectus femoris	Mild tone	Moderate weakness
Both hamstrings	Mild tone	Moderate weakness

Comment:

- Mildly increased H/M ratio and F/M ratio and in both lower limbs denoting mild hypertonia.
- No spontaneous motor unit firing in both gastrocnemius. Both tibialis anterior, rectus femoris and hamstring muscles showed spontaneous firing at low rates.

Motor NCS(1)

Nerve / Sites	Muscle	Latency ms	Amplitude mV	Rel Amp %	Segments	Distance mm	Lat Diff ms	Velocity m/s	Rel Vel %
R Tibial - AH									
Ankle	AH	1.81	14.3	100	Ankle - AH	80			
Knee	AH	5.52	10.4	73	Knee - Ankle	190	3.71	51	100
L Tibial - AH									
Ankle	AH	2.15	12.5	100	Ankle - AH	80			
Knee	AH	5.92	12.6	100	Knee - Ankle	190	3.77	50	100

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Figure (2): Nerve conduction velocity.

Figure (3): Assessment of growth motor function classification scale GMFCS.

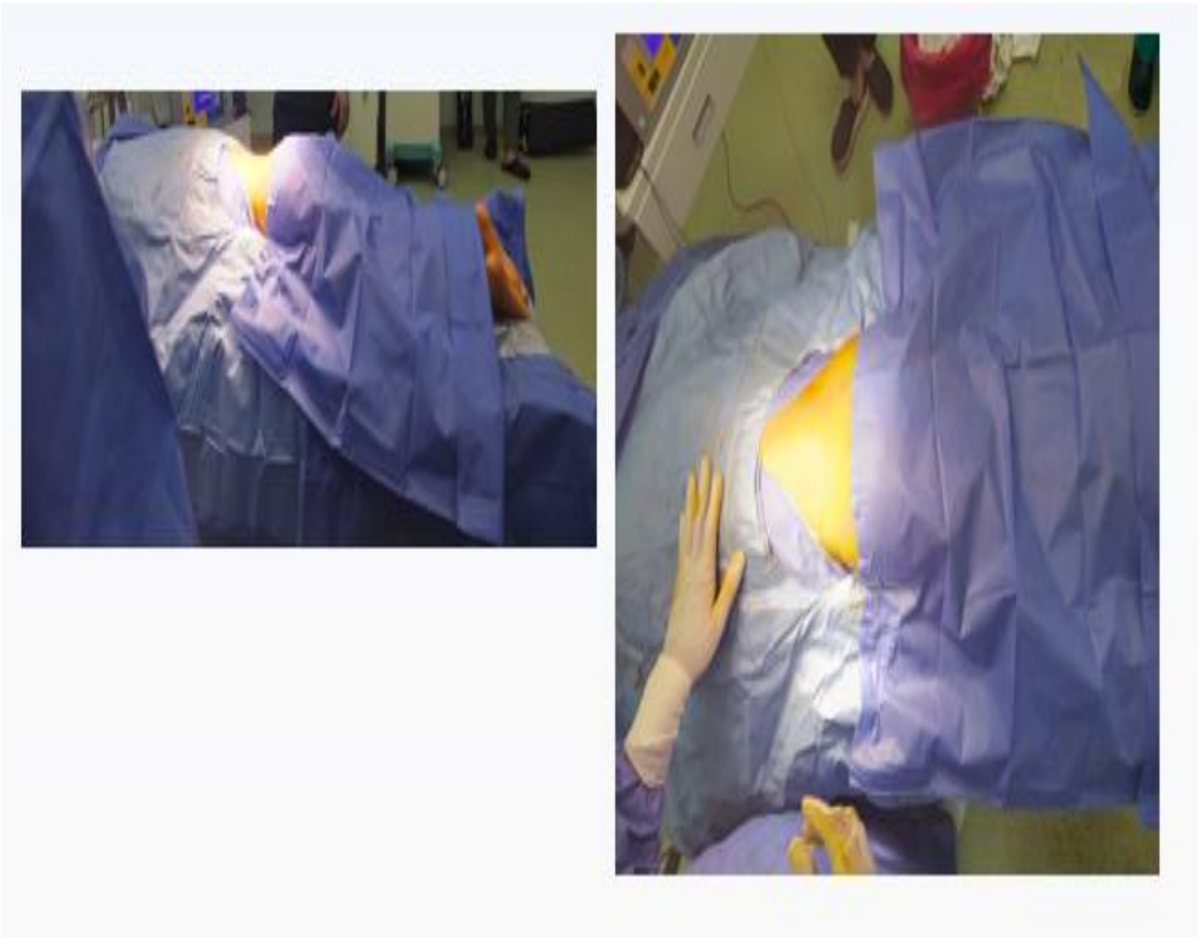

Figure (4): Surgical technique Prone position.

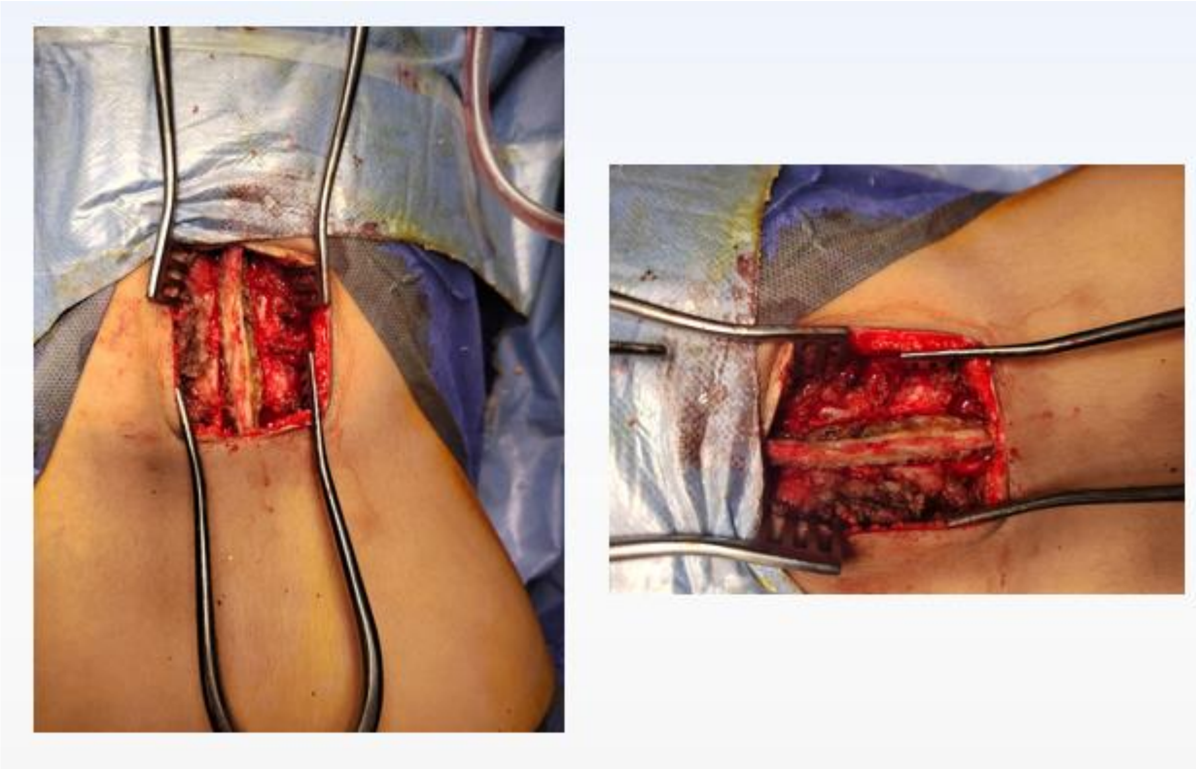

Figure (5): Subperiosteal paravertebral muscles dissection.

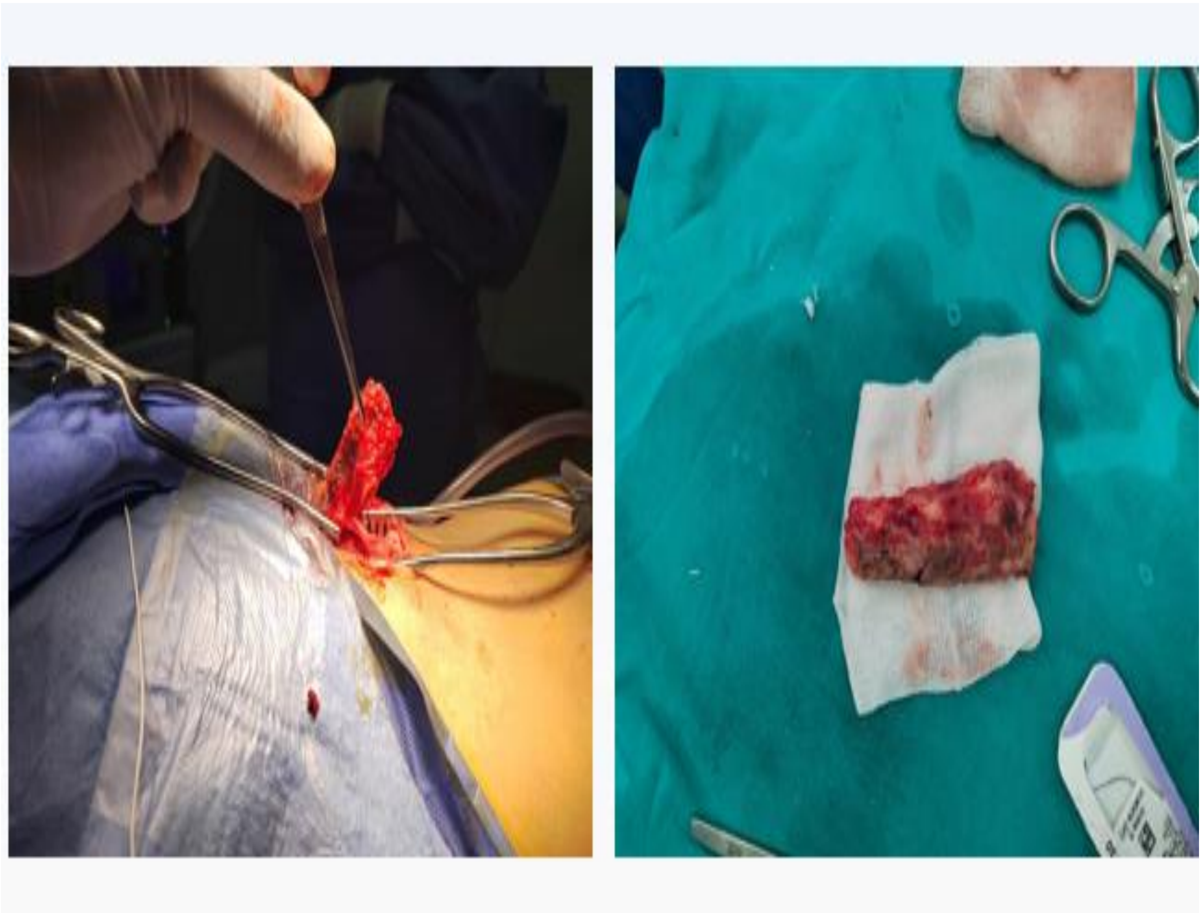

Figure (6): Bilateral removal of spinolaminae in the form of laminoplasty manner.

Figure (7): Midline incision of the dura.

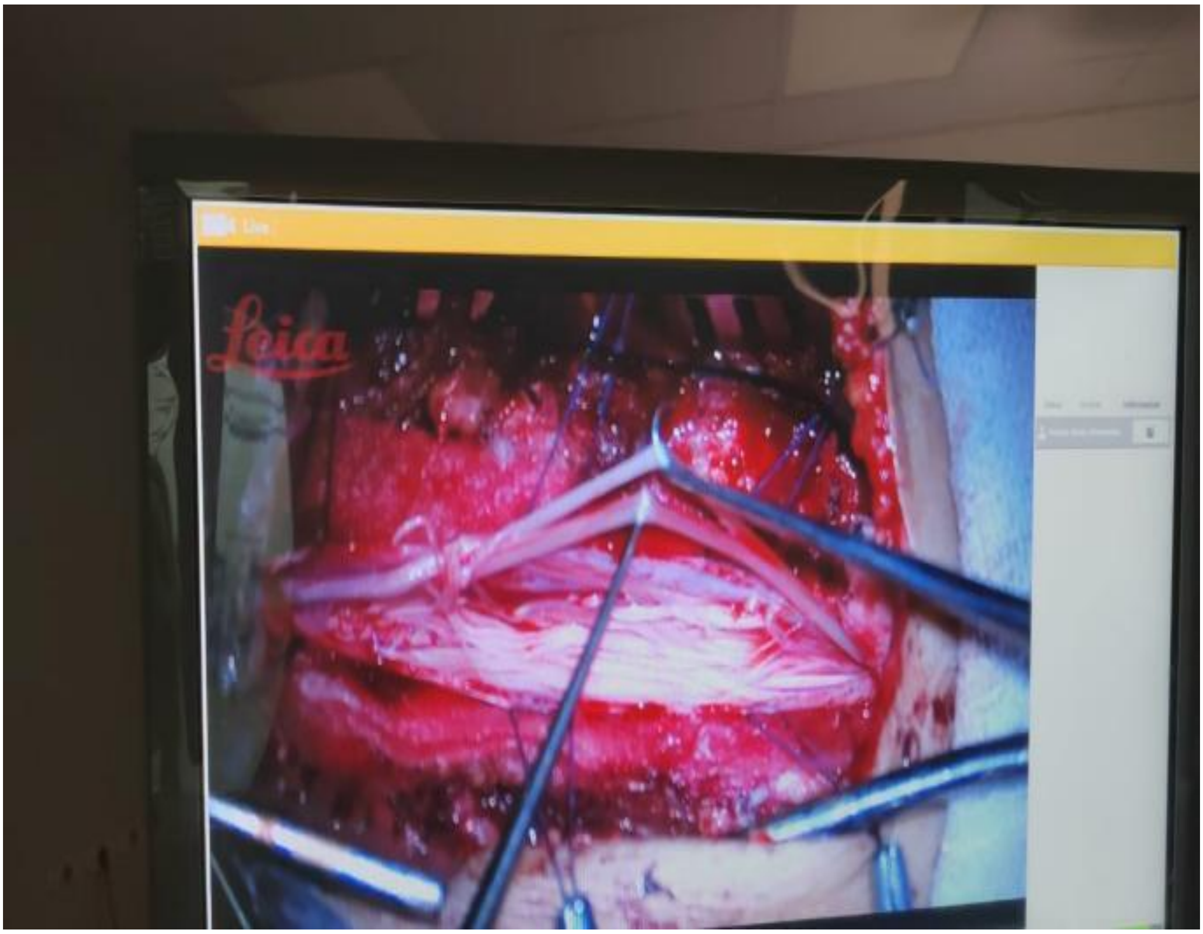

Figure (8): Identification of roots bilaterally.

Figure (9): Selective microscopic cutting and cauterization of bilateral D12-S1 dorsal roots (50%).

4. Discussion

Spasticity is a motor condition distinguished by a velocity-dependent amplification of stretch reflexes caused by faulty intraspinal processing of primary afferent information. This means greater muscular tone, improved tendon reflexes, expanded reflex zones, and clonus in clinical terms. Spasms are abrupt involuntary muscular spasms that are common in people with SCL, particularly those correlating to knee extension and hip flexion [8]. In this study, a total sample of 20 patients with the mean age of patients was 21.1 ± 9.0 years and ranged from 3 to 40 years. Cranial nerves were affected insignificantly in 9 cases (45%). No significant difference regarding limb affection between hemispastic (30%), paraspastic (25%), quadrispastic (20%) and diplegic spasticity (25%) (P >0.05).

Park et al., [9] conducted a cohort study that reviewed 85 outcome studies from 12 countries between 1990 and 2017. In this patient cohort, 84% had diplegia, 12% had quadriplegia, and 4% had triplegia.

Also, Nasser Abdul-Hamid Al-Sayed et al., [10] reported that 100% of the patients with spasticity had spastic paraparesis while there were 50% had spastic quadriparesis.

The Ashworth scale is the most universally accepted clinical tool used to measure the increase of muscle tone. In 1964, Bryan Ashworth published the Ashworth Scale as a method of grading spasticity while working with multiple sclerosis patients. The original Ashworth scale was a 5-point numerical scale that graded spasticity from 0 to 4, with 0 being no resistance and 4 being a limb rigid in flexion or extension.[11]

In this study, Most of the cases (60%) had Ashworth scale 3, significantly higher than scale 1 (5%), scale 2 (30%), and scale 4 (5%) (P <0.05).

In a study by Bakheit et al., [12] there were 12% scored 3 on the Ashworth scale, 40% scored 2, and 48% scored 1 among patients with spasticity.

In the current study, regarding gait classification, most of cases (60%) had GMFCS scale 3(Walks with assistive mobility devices indoors and outdoors on level surfaces), significantly higher than scale 1 (5%), scale 2 (25%), scale 4 (5%)(Walking ability severely limited even with assistive devices), and scale 5 (5%)(Has physical impairments that restrict voluntary control of movement and the ability to maintain head and neck position against gravity) (P.<0.05).

Consistent with our results, Hurvitz et al., [13] used the GMFCS scale and found that 7% were level 1, 18% were level 2, 23% were level 3, 36% were level 4 and 18% were level 5.

In this study, regarding causes of spasticity, most of the cases (90%) had CP, significantly higher than cases with spinal injury (10%) (P.<0.05).

In this study, postoperative status was improved significantly in 60% of cases, while 30% of cases remained as preoperative status, and 10% deteriorated.

MacWilliams et al., [14] agreed that selective dorsal rhizotomy improves the spasticity among the patients. At long-term assessment, 100% of participants in the Yes-SDR group were in the mild spasticity category. Clinically measured spasticity was clearly and substantially reduced in the Yes-SDR group and unchanged in the No-SDR group.

The results reported by Park et al., [9] were similar to ours. It showed that SDR plus postoperative physiotherapy (PT) improved gait, functional independence, and self-care in patients with spastic diplegia.The reduction of spasticity with SDR can prevent or even reverse premature ageing.

A significant improvement compared with the expected 61% intervention rate for patients with spasticity after SD was reported by Watt et al [15].

Chicoine et al., [16] declined that the majority of former patients with SDR report improvements and that they would recommend SDR, with very few reporting negative impressions of the procedure.

In the current study, selective dorsal rhizotomy showed mild postoperative complications as back pain was the most common complication (85%), in comparison to other complications while CSF leak, paraplegia, and wound infection were significantly absent in 75%, 90%, 80% of cases respectively.

In the same line with our results, Al-Sayed [10] reported that the most common complication is post-operative back pain (22 patients); 73.3% of the selected group, which is easily managed by analgesics, while other complications show very little percentage, wound infection (3 patients); 10%, can be managed easily by antibiotics and regular wound care, other complications while low in percentage, still doesn't cause mortality.

5. Conclusion

This study concluded that selective dorsal rhizotomy may be a good and safe option for the treatment of spasticity and may improve the condition of the spasticity among patients. Our results showed that, Most of cases had Ashworth scale 3, significantly higher than scale 1. Regarding gait classification, most cases had GMFCS scale 3, significantly higher than scale 1. Regarding causes of spasticity, most of cases had CP, significantly higher than cases with spinal injury . Postoperative status was improved significantly in 60 % of cases. Back pain was significantly the most common complication in comparison to other complications.

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Conflicts of interest: No competing interests.

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