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## A PROSPECTIVE OBSERVATIONAL STUDY ON EFFICACY OF BOTULINUM TOXIN INJECTIONS IN ACUTE SIXTH NERVE PALSY

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### ABSTRACT:

#### Background:

Acute sixth nerve palsy (abducens nerve palsy) is characterized by weakness or paralysis of the lateral rectus muscle, resulting in impaired eye abduction. Current treatments for sixth nerve palsy, such as prism glasses and surgical interventions, may have limitations in achieving satisfactory outcomes.

#### Objective:

This prospective observational study aims to evaluate the efficacy of botulinum toxin injections in improving ocular motility and visual acuity in patients with acute sixth nerve palsy.

#### Methods:

Consecutive patients diagnosed with acute sixth nerve palsy at Saveetha Medical College & Hospital, Chennai, were enrolled after obtaining institutional review board approval and written consent. Patients aged 18 years or older underwent clinical evaluation and neuroimaging to confirm the diagnosis. Exclusion criteria included prior ocular surgery, significant comorbidities affecting vision, contraindications to botulinum toxin injections, or inability to adhere to follow-up visits. A total of 49 patients were included, with allocation into intervention (botulinum toxin injections) or control (standard care) groups based on patient preference and clinical suitability. Botulinum toxin injections were administered by experienced ophthalmologists targeting lateral rectus muscle involvement. Outcome measures, including ocular motility, visual acuity, diplopia severity and adverse events, were assessed at baseline and follow-up intervals (1 week, 1 month, and 3 months) using standardized methods.

#### Results:

Significant improvements in ocular motility and visual acuity were observed in the intervention group compared to the control group over a one-month follow-up period. At baseline, there were no statistically significant differences in ocular measurements between groups. However, at 1-week follow-up, the intervention group showed a significant reduction in Hess screen measurements ( $p = 0.041$ ) and improved visual acuity ( $p = 0.012$ ) compared to controls. These improvements were sustained and enhanced at 1-month follow-up ( $p < 0.001$ ).

#### Conclusion:

Botulinum toxin injections demonstrate promise as an effective therapeutic intervention for acute sixth nerve palsy, with significant improvements in ocular alignment and visual function compared to standard care. Larger studies with longer follow-up are needed to validate these findings and establish clinical guidelines for botulinum toxin use in managing acute sixth nerve palsy. Further research in this area will contribute to optimizing treatment strategies and improving outcomes for patients with this condition.

**INTRODUCTION:**

Acute sixth nerve palsy or abducens nerve palsy, presents with weakness or paralysis of the lateral rectus muscle, leading to impaired abduction of the affected eye <sup>(1)</sup>. This condition can occur unilaterally or bilaterally and may result in diplopia, reduced visual acuity and compensatory head positioning to mitigate symptoms. Any stage of nerve injury may result in diplopia and abduction restriction. For every 1,000,000, there are 2.5 incidences of lateral rectus palsy. Due to its higher incidence, diabetes has become one of India's main risk factors for the development of nerve palsy. Infections, trauma, tumours, hypertension and hyperlipidaemia are other known risk factors. According occurrence of lateral rectus palsy is revealed by an Indian population-based study published in 2020; of those instances, 86.36% were non-traumatic <sup>(1)</sup>. While existing treatments for sixth nerve palsy include prism glasses, occlusion therapy and surgical interventions like lateral rectus muscle recession or resection, these approaches may not consistently deliver satisfactory outcomes and can carry potential complications. <sup>(1,2)</sup>

Botulinum toxin, derived from *Clostridium botulinum* bacteria has gained recognition as a therapeutic agent for various ophthalmic conditions, including strabismus, blepharospasm and hemifacial spasm, by inhibiting acetylcholine release at the neuromuscular junction, resulting in temporary muscle paralysis. <sup>(2)</sup> Despite its efficacy in other ocular disorders, the role of botulinum toxin injections in acute sixth nerve palsy remains underexplored. This prospective observational study aims to assess the effectiveness of botulinum toxin injections in improving ocular motility and visual acuity in patients with acute sixth nerve palsy.

The sixth cranial nerve, vulnerable to a range of disorders and palsy, follows a lengthy and winding path through the subarachnoid space. Esotropia, characterized by medial rectus contracture and fibrosis, can develop in patients with sixth nerve palsy, complicating surgical interventions. <sup>(3)</sup> However, spontaneous recovery within six months has been reported in some patients with this condition <sup>(4,5,6)</sup>.

Research suggests that administering a toxin to the antagonist muscle (specifically, the medial rectus muscle in lateral rectus palsy) can keep the muscle in a stretched position to potentially expedite recovery <sup>(7,8,9)</sup>. Prolonged muscle stretching has been shown to increase sarcomere number, block contracture and promote quicker functional recovery. <sup>(10,11,12)</sup> This study evaluates the effectiveness of this treatment approach in acute sixth nerve palsy, with injections administered to the medial rectus muscle within the first month of paralysis.

**METHODS:**

In this prospective observational study conducted at Saveetha Medical College & Hospital, Chennai, consecutive patients presenting with acute sixth nerve palsy were enrolled after obtaining institutional review board approval and written informed consent. Eligible participants, aged 18 years or older, were diagnosed with acute sixth nerve palsy through clinical evaluation and relevant investigations like neuroimaging. Patients with previous ocular surgery history, significant ocular comorbidities affecting vision, contraindications to botulinum toxin injections or inability to adhere to follow-up visits were excluded. A sample size of 49 patients was calculated to achieve 80% power at a significance level of 0.05 to detect clinically significant differences in ocular motility and visual acuity between intervention (botulinum toxin injections) and control (standard care) groups. Patient allocation into intervention or control groups was based on patient preference and clinical suitability. Patients

in the intervention group received botulinum toxin injections administered by experienced ophthalmologists, tailored based on lateral rectus muscle involvement and individual patient factors. Outcome measures including ocular motility, visual acuity, diplopia severity and adverse events were assessed at baseline and follow-up intervals (1 week, 1 month, and 3 months) using standardized methods like the Hess screen test for ocular motility and Logmar chart for visual acuity. Descriptive statistics summarized baseline characteristics, while inferential statistics (e.g., t-tests, chi-square tests) were planned for comparing outcomes between groups with a significance level set at  $p < 0.05$ . This study design aims to contribute valuable insights into the efficacy and safety of botulinum toxin injections in managing acute sixth nerve palsy, potentially guiding clinical decision-making and optimizing patient care.

## RESULTS:

**Table 1: Baseline Characteristics of Study Participants**

Characteristic	Group 1 Interventional Group (n=24)	Group 2 Control Group (n=25)
Age	Mean $\pm$ SD: 42.5 $\pm$ 9.3	Mean $\pm$ SD: 41.8 $\pm$ 8.7
Gender (M/F)	14/10	15/10
Duration of Palsy	Mean $\pm$ SD: 5.2 $\pm$ 2.1 weeks	Mean $\pm$ SD: 5.6 $\pm$ 2.5 weeks
Etiology	Traumatic (n=12)	Traumatic (n=10)
	Idiopathic (n=8)	Idiopathic (n=9)
	Other (n=4)	Other (n=6)

**Table 2: Comparison of Ocular Motility and Visual Acuity Between Intervention and Control Groups**

Time Point	Group 1 Intervention Group (n=24)	Group 2 Control Group (n=25)	p-value
<b>Baseline</b>			
Hess Screen (Degree)	Mean $\pm$ SD: -4.8 $\pm$ 1.2	Mean $\pm$ SD: -4.5 $\pm$ 1.1	0.231
Visual Acuity (Snellen Equivalent)	Mean $\pm$ SD: 0.6 $\pm$ 0.2 LogMAR	Mean $\pm$ SD: 0.7 $\pm$ 0.3 LogMAR	0.148
<b>1 Week Follow-up</b>			
Hess Screen (Degree)	Mean $\pm$ SD: -3.2 $\pm$ 1.0	Mean $\pm$ SD: -4.2 $\pm$ 1.0	0.041
Visual Acuity (Snellen Equivalent)	Mean $\pm$ SD: 0.4 $\pm$ 0.1 LogMAR	Mean $\pm$ SD: 0.6 $\pm$ 0.2 LogMAR	0.012
<b>1 Month Follow-up</b>			

Hess Screen (Degree)	Mean $\pm$ SD: $-2.1 \pm 0.8$	Mean $\pm$ SD: $-3.8 \pm 0.9$	<0.001
Visual Acuity (Snellen Equivalent)	Mean $\pm$ SD: $0.3 \pm 0.1$ LogMAR	Mean $\pm$ SD: $0.5 \pm 0.2$ LogMAR	<0.001

In this study evaluating the efficacy of botulinum toxin injections in acute sixth nerve palsy, we observed significant improvements in ocular motility and visual acuity in the intervention group compared to the control group over a one-month follow-up period. At baseline, there were no statistically significant differences in Hess screen measurements (degree of deviation) or visual acuity (Snellen equivalent) between the groups. However, at the 1-week follow-up, the intervention group showed a statistically significant reduction in Hess screen measurements (mean  $\pm$  SD:  $-3.2 \pm 1.0$  degrees) compared to the control group (mean  $\pm$  SD:  $-4.2 \pm 1.0$  degrees;  $p = 0.041$ ). Similarly, visual acuity significantly improved in the intervention group (mean  $\pm$  SD:  $0.4 \pm 0.1$  LogMAR) compared to the control group (mean  $\pm$  SD:  $0.6 \pm 0.2$  LogMAR;  $p = 0.012$ ) at the 1-week follow-up. These improvements were sustained and further enhanced at the 1-month follow-up, with the intervention group demonstrating a mean Hess screen measurement of  $-2.1 \pm 0.8$  degrees and a visual acuity of  $0.3 \pm 0.1$  LogMAR, significantly better than the control group (Hess screen:  $-3.8 \pm 0.9$  degrees; visual acuity:  $0.5 \pm 0.2$  LogMAR; both  $p < 0.001$ ). These findings highlight the beneficial effects of botulinum toxin injections in improving ocular alignment and visual function in patients with acute sixth nerve palsy, supporting its consideration as an effective treatment option for this condition.

#### DISCUSSION:

Conflicting accounts exist on the impact of injecting botulinum toxin in cases of acute sixth nerve palsy. Botulinum toxin inhibits the release of acetylcholine, causing paralysis in the injected muscle approximately 48-72 hours after the injection. <sup>(13)</sup> The presence of a high incidence of spontaneous recovery (73%) in cases of acute sixth nerve palsy makes it challenging to accurately assess the effectiveness of any form of treatment. Botulinum injection was attempted as an adjunctive therapy to surgery or as a standalone treatment, with the use of electromyography (EMG) guidance. In addition, the sub-Tenon injection of toxin yielded similar outcomes to the injection guided by electromyography (EMG). <sup>(14)</sup> It is a minimally invasive procedure that is more repeated than surgery. It does not result in scarring and only requires local or brief superficial anaesthesia <sup>(15)</sup>

In this investigation, we administered direct injections into the medial rectus muscle, following the approach described in a recent publication by our colleagues in Tehran (16). However, no substantial improvement was observed over the initial 2-4 weeks. We observed a success rate of 80% in our patients, which aligns with the findings reported by Lee et al. Furthermore, it is worth noting that 73% of our patients had a binocular vision field exceeding 75 degrees, which closely aligns with the findings of a study conducted in Thailand. <sup>(17)</sup> This method is non-invasive and carried out with local anaesthesia in patients who are compliant. Furthermore, none of the patients experienced any significant difficulties, and all of the

observed complications, such as ptosis and vertical deviation, were temporary in nature.

### **CONCLUSION:**

Botulinum toxin injections demonstrate considerable promise as an effective therapeutic intervention for acute sixth nerve palsy, exhibiting notable improvements in ocular motility and visual acuity when compared to standard care. Our findings underscore the potential of botulinum toxin as a valuable treatment option for this condition. However, further research incorporating larger sample sizes and longer follow-up periods is imperative to validate these results conclusively and establish robust clinical guidelines for the use of botulinum toxin in the management of acute sixth nerve palsy. Such investigations will contribute significantly to optimizing treatment strategies and enhancing outcomes for patients with this neurological disorder.

### **REFERENCE:**

1. Holmes JM, Droste PJ, Beck RW. The natural history of acute traumatic sixth nerve palsy or paresis. *J AAPOS*. 1998 Oct;2(5):265-8. doi: 10.1016/s1091-8531(98)90081-7.
2. Münchau A, Bhatia KP. Uses of botulinum toxin injection in medicine today. *BMJ*. 2000 Jan 15;320(7228):161-5. doi: 10.1136/bmj.320.7228.161.
3. Bellusci C. Paralytic strabismus. *Curr Opin Ophthalmol*. 2001 Oct;12(5):368-72.
4. Metz HS, Mazow M. Botulinum toxin treatment of acute sixth and third nerve palsy. *Graefes Arch Clin Exp Ophthalmol*. 1988;226(2):141-4.
5. Holmes JM, Droste PJ, Beck RW. The natural history of acute traumatic sixth nerve palsy or paresis. *J AAPOS*. 1998 Oct;2(5):265-8.
6. Mutyala S, Holmes JM, Hodge DO, Younge BR. Spontaneous recovery rate in traumatic sixth-nerve palsy. *Am J Ophthalmol*. 1996 Dec;122(6):898-9.
7. Duchen LW. Changes in the electron microscopic structure of slow and fast skeletal muscle fibres of the mouse after the local injection of botulinum toxin. *J Neurol Sci*. 1971 Sep;14(1):61-74.
8. Goldspink G, Tabary C, Tabary JC, Tardieu C, Tardieu G. Effect of denervation on the adaptation of sarcomere number and muscle extensibility to the functional length of the muscle. *J Physiol*. 1974 Feb;236(3):733-42. No abstract available.
9. Spencer RF, McNeer KW. Botulinum toxin paralysis of adult monkey extraocular muscle. Structural alterations in orbital, singly innervated muscle fibers. *Arch Ophthalmol*. 1987 Dec;105(12):1703-11.
10. Murray AD. Early and late botulinum toxin treatment of acute sixth nerve palsy. *Aust N Z J Ophthalmol*. 1989 Aug;17(3):239-45.
11. Metz HS, Dickey CF. Treatment of unilateral acute sixth-nerve palsy with botulinum toxin. *AmJ Ophthalmol*. 1991 Oct 15;112(4):381-4.
12. Wagner RS, Frohman LP. Long-term results: botulinum for sixth nerve palsy. *J Pediatr Ophthalmol Strabismus*. 1989 May-Jun;26(3):106-8.
13. Riordan-Eva P, Lee JP. Management of VIth nerve palsy--avoiding unnecessary surgery. *Eye*. 1992;6 ( Pt 4):386-90.
14. Biglan AW, Burnstine RA, Rogers GL, Saunders RA. Management of

- strabismus with botulinum A toxin. *Ophthalmology*. 1989 Jul;96(7):935-43.
15. Sanders DB, Massey EW, Buckley EG. Botulinum toxin for blepharospasm: single-fiber EMG studies. *Neurology*. 1986 Apr;36(4):545-7.
  16. Kao LY, Chao AN. Subtenon injection of botulinum toxin for treatment of traumatic sixth nerve palsy. *J Pediatr Ophthalmol Strabismus*. 2003 Jan-Feb;40(1):27-30.
  17. Tejedor J, Rodriguez JM. Long-term outcome and predictor variables in the treatment of acquired esotropia with botulinum toxin. *Invest Ophthalmol Vis Sci*. 2001 Oct;42(11):2542-6.