International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Exploring Physiotherapy Strategies for Managing Neurological Deficits in a Hypertrophic Pachymeningitis Patient: A Case Study

Shubham Vinay Gajare[1], Dr Shyam Kurapati[2]

[1]PG Student, Dr. APJ Abdul Kalam College of Physiotherapy, Loni, Ahmednagar, Maharashtra, India
Corresponding Author Email: *shubhamphysio8249[at]gmail.com*

[2]HOD Neuro-Physiotherapy, Dr. APJ Abdul Kalam College of Physiotherapy, Loni, Ahmednagar, Maharashtra, India
Email: *kurapatishyam82[at]gmail.com*

Abstract: ***Introduction**: Pachymeningitis is a fibrosing and inflammatory process, which involves the dura mater. Some pachymeningitis are cranial and induce headaches and cranial nerve palsies. The cavernous sinus is a critical anatomical structure that houses important nerves, including the oculomotor, trochlear, and abducens nerves, as well as the trigeminal nerve. This case study aims to investigate the effectiveness of physiotherapy strategies in managing the neurological deficits associated with pachymeningitis and cavernous sinus involvement. **Objectives**: The primary objective of this case study is to evaluate the effectiveness of saccade and pursuit training along with TENS and Masticatory muscle training to subside the symptoms in a patient who developed diplopia and right facial numbness and pain following pachymeningitis with cavernous sinus involvement. **Methodology**: A single case study was conducted with a 35-year-old female patient who developed diplopia and right facial numbness and pain following pachymeningitis with cavernous sinus involvement. The patient received saccade and pursuit training along with TENS and Masticatory muscle training with treatments administered three times a week for 6 weeks. Clinical assessments, including the Ocular Motor Nerve Palsy Scale (OMNPS), Modified Medical Research Council scale (MRCS), Diplopia Questionnaire (DQ) were performed before, during, and after the treatment period. **Results**: Post intervention assessments showed high significant improvements in pain reduction and significant improvement in motor function. **Conclusion**: This case study highlights the potential benefits of physiotherapy in managing neurological deficits associated with pachymeningitis with cavernous sinus involvement. The findings suggest that a personalized physiotherapy approach can lead to meaningful improvements in motor function, pain management. Further studies with larger sample sizes are needed to validate these findings and refine rehabilitation strategies for pachymeningitis patients.*

Keywords: Pachymeningitis, Cavernous Sinus, TENS, OMNPS, Modified MRCS, DQ

1. Introduction

Hypertrophic pachymeningitis (HP) is a rare, long-lasting inflammatory disorder. It is marked by thickening of the dura mater, which can be either localized or widespread. This condition involves different levels of fibrosis, inflammation, and enhancement of the dura on contrast imaging. Clinically, HP can show up as a persistent headache, focal neurological deficits, and worsening cranial neuropathies. When the disease affects the cavernous sinus or the dura around the sella, patients often experience painful ophthalmoplegia and issues with cranial nerves III, IV, V (V1/V2), and VI. The causes of HP vary widely. They include idiopathic (formerly called "idiopathic hypertrophic pachymeningitis"), infectious (such as tuberculosis, syphilis, and fungal infections), granulomatous, neoplastic, and immune-mediated issues (like IgG4-related disease). Diagnosis often requires combining clinical data, imaging results, serologic tests, and sometimes histopathology.

Dural inflammation and fibrosis can cause mass effect and extend into nearby neurovascular structures. When the cavernous sinus or nearby dural compartments are involved, they may compress or inflame cranial nerve bundles and surrounding meningeal sensory fibers. This can lead to symptoms like ophthalmoplegia, diplopia, ptosis, facial numbness, trigeminal pain, and less frequently, masticatory or bulbar dysfunction. For diagnosis, contrast-enhanced MRI is preferred. T1 sequences with gadolinium usually show linear or nodular dural enhancement and thickening that matches the areas of clinical deficit. If recognized and treated early, often with corticosteroids, immunosuppression, or targeted antimicrobial therapy, the progression can be halted, and in some cases, neurologic dysfunction can be partially reversed. However, residual deficits often remain, highlighting the need for rehabilitation interventions.

From a rehabilitation standpoint, pachymeningitis poses a unique clinical challenge. The pattern of deficits usually includes sensorimotor problems linked to cranial nerves, such as eye movement issues, facial weakness, sensory loss in the trigeminal nerve, and chewing difficulties. There may also be balance problems if nearby structures are impacted, along with general weakness due to pain and long medical treatments. While medical treatments focus on controlling inflammation and stopping further damage to the dura, physiotherapy and related rehabilitation methods are crucial. They help maximize recovery, lower disability, and enhance the quality of life for those affected.

Several evidence-based rehabilitation methods are relevant to the common deficits seen in HP. Oculomotor rehabilitation, which includes saccade and pursuit training, gaze stabilization, and graded visual-motor tasks, makes use of intact oculomotor learning mechanisms. It has shown benefits for saccadic metrics, pursuit quality, and symptom reduction in other neurological groups. These interventions are reasonable and may be effective when cranial nerve III, IV, or

VI dysfunction, or oculomotor incoordination continues after medical stabilization. Similarly, vestibular and gaze-stability rehabilitation, which includes vestibulo-ocular reflex adaptation and compensatory strategies, can reduce dizziness and improve dynamic balance when vestibular pathways are also involved. Similarly the disease involves trigeminal nerve which causes pain over facial area,. many treatment modalities have been described for facial pain from time to time. Conventional modalities have major disadvantage leading to reduced patient compliance. Hence, attempts have been made to use non- invasive procedures like TENS which can be used alone or as an adjuvant. TENS uses electric current to activate nerves in order to decrease pain. Studies have reported that TENS is a promising and safe modality for TN with increased patient compliance.

This case study aims to investigate the effectiveness of physiotherapy strategies in managing the neurological deficits associated with pachymeningitis and cavernous sinus involvement.

2. Need of the Study

Pachymeningitis is a rare inflammatory disorder of the dura mater that may extend to regions such as the cavernous sinus, resulting in cranial nerve palsies, ocular motor dysfunction, facial weakness, balance disturbances, and functional limitations. While medical management with corticosteroids, immunosuppressants, or antimicrobial therapy addresses the primary inflammation, many patients continue to experience residual neurological deficits that hinder daily activities and reduce quality of life. Despite these long-term impairments, there is currently no standardized physiotherapy protocol for managing functional deficits in pachymeningitis, and rehabilitation-focused literature remains extremely limited.

Physiotherapy interventions such as oculomotor rehabilitation, balance and vestibular training, facial neuromuscular retraining, masticatory muscle training, and TENS have proven effective in related neurological conditions like cranial neuropathies. However, their application in pachymeningitis has not been systematically evaluated.

Therefore, this study is needed to explore whether integrating physiotherapy strategies can manage neurological deficit in hypertrophic pachymeningitis patient with the involvement of cavernous sinus.

3. Case Study

A 35-year-old female presented with on-and-off fever (102ºF) for four days with headache and generalized weakness in both upper and lower limbs along with right facial numbness and pain. All necessary investigations were performed in hospital. On evaluation, the patient was diagnosed with pachymeningitis with cavernous sinus involvement. For which she was admitted for 8 days in the duration of which she received to treat headache various combination of pregabalin, gabapentin and antibiotics. After 2 days patient developed right side diplopia with gaze limitation. After which she had been refered for Physiotherapy.
Upon Examination,

Modified Medical Research Council scale (MRCS)

Grade S2+ (Superficial pain and touch plus hyperesthesia)

Ocular Motor Nerve Palsy Scale (OMNPS)

Diplopia in 1mm-Grade 3 (Max deviation)

Eye movement –
Horizontal Grade 3 (reach or exceed ¼ line which is the opposite side of the paralyzed direction, cannot reach or exceed midline)

Vertical Grade 2 (Affected eye pupil on the line of inner and temporal canthus)

Palpebral Fissure – Grade 3 (Force on the eyebrow could see a small fissure)

Pupil-Grade 2 (Difference in 2.0-3.0 mm)

Light Reflex-Grade 1 (Slow)

Diplopia Questionnaire (DQ)

If YES:
- *Put an "X" in the box which best describes your double vision over the past week.*
- *Mark only one box per question.*

During the last week, did you have double vision when …	Always (100%)	Often (~75%)	Sometimes (~50%)	Rarely (~5%)	Never (0%)
1) reading (in a normal reading position)?	☐	■	☐	☐	☐
2) looking straight ahead in the distance?	☐	■	☐	☐	☐
3) looking up?	☐	☐	■	☐	☐
4) looking down?	☐	☐	☐	■	☐
5) looking right?	☐	☐	☐	☐	☐
6) looking left?	☐	☐	■	■	☐
7) looking in any other position?	☐	☐	☐	■	☐

Protocol

Protocol	Duration	Volume	Frequency
1. TENS (F-20Hz/PW-100us)	15 MIN		MONDAY–FRIDAY
2. Gentle eye movements, facial exercise	10 MIN		
3. Saccade exercises • Horizontal saccade • Verticle saccade • Diagonal saccade • Target with fixed start/end point	10 MIN	10Reps*3Sets	
4. Pursuit exercises • Horizontal pursuits • Verticle Pursuits • Circular Pursuits • Pursuits with object variety	10 MIN	10Reps*3Sets	
5. Masticatory muscle training	5 MIN	10Reps*3Sets	

Outcome Measure

Outcome Measures	PRE- TEST	POST- TEST
Modified Medical Research Council scale (MRCS)	Grade 2+	Grade 4
Ocular Motor Nerve Palsy Scale (OMNPS)	20	5

Diplopia Questionnaire (DQ)

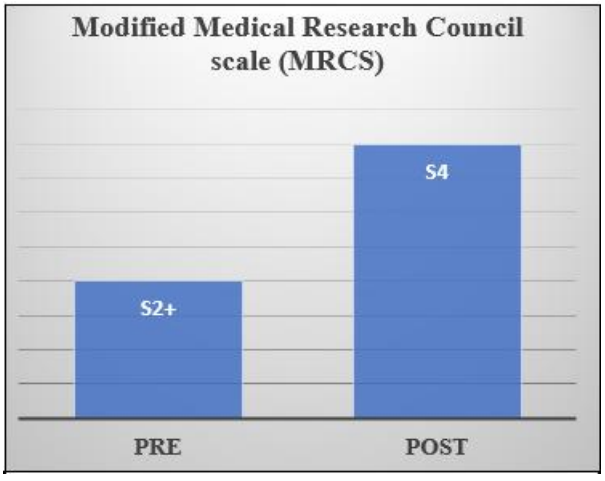
If YES:

- ***Put an "X" in the box which best describes your double vision over the past week.***
- ***Mark only one box per question.***

During the last week, did you have double vision when …	Always (100%)	Often (~75%)	Sometimes (~50%)	Rarely (~5%)	Never (0%)
1) reading (in a normal reading position)?	☐	☐	■	☐	☐
2) looking straight ahead in the distance?	☐	☐	☐	■	☐
3) looking up?	☐	☐	☐	■	☐
4) looking down?	☐	☐	☐	☐	■
5) looking right?	☐	☐	☐	■	☐
6) looking left?	☐	☐	☐	■	☐
7) looking in any other position?	☐	☐	☐	■	☐

4. Result

Post intervention assessments showed high significant improvements in pain reduction and significant improvement in motor function.



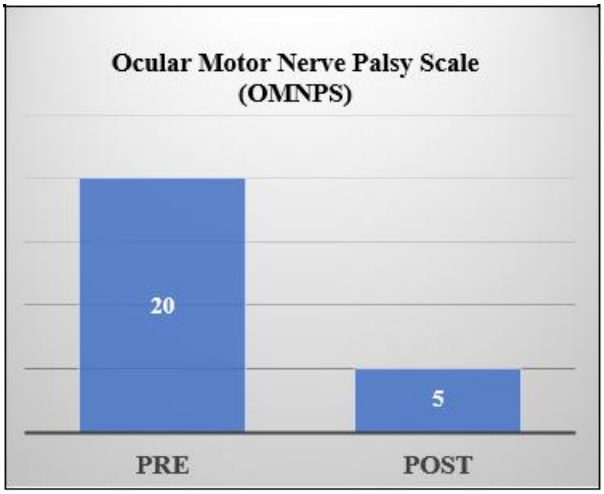


Chart 2

5. Discussion

This case study shows how an organized physiotherapy program effectively addresses neurological issues linked to

hypertrophic pachymeningitis (HP). HP is a rare inflammatory condition that causes thickening of the dura mater. This often leads to nerve damage, affecting eye movement and causing overall muscle weakness due to nerve compression or inflammation. While treatment mainly involves medications like corticosteroids, immunosuppressants, or antibiotics, some neurological issues may continue, requiring rehabilitation. In this case, physiotherapy strategies were tailored to improve eye movement control and limb strength. The Modified Medical Research Council Scale (MRCS) showed a movements and resistance handling. This fits with previous findings indicating that progressive resistance training and neuromuscular techniques help recovery, even in chronic nerve conditions.

The patient also showed significant recovery in cranial nerve function. The Ocular Motor Nerve Palsy Scale (OMNPS) improved from 20, indicating severe impairment, to 5, indicating mild dysfunction. Techniques for eye movement rehabilitation, such as pursuit and saccadic training, along with gaze stabilization and vestibulo-ocular reflex (VOR) exercises, likely helped improve coordination of the extraocular muscles and proprioceptive feedback. Similar results have been observed in patients with oculomotor problems due to multiple sclerosis and traumatic brain injury, where organized visual-motor therapy significantly restored stable gaze.

The improvements in both motor and eye movement functions suggest that neuroplasticity can occur even in rare inflammatory neurological conditions when physiotherapy is combined with medical treatment. This supports emerging evidence that early rehabilitation should be included in neuro-inflammatory disorders to prevent further complications like muscle wasting, balance issues, and reliance on vision.

According to Mukta Motwani TENS can be an effective treatment modality for facial numbness in the involvement of trigeminal nerve in reducing the pain intensity with no reported side effect.

6. Conclusion

This case study highlights the potential benefits of physiotherapy in managing neurological deficits associated with pachymeningitis with cavernous sinus involvement. The findings suggest that a personalized physiotherapy approach can lead to meaningful improvements in motor function, pain management. Further studies with larger sample sizes are needed to validate these findings and refine rehabilitation strategies for pachymeningitis patients.

References

[1] Mukta Motwani, Aditi Fadnavis; Efficacy of transcutaneous electrical nerve stimulation (TENS) in the management of trigeminal neuralgia: A systematic review and meta-analysis; 2023 June 1; 15 (6)
[2] Abrantes FF; A clinical approach to pachymeningitis; 2020 dec; 78 (12)
[3] Shnyakin PG, Isaeva NV; Idiopathic hypertrophic pachymeningitis; 2024; 124 (3: 114-119)
[4] Barton JJS; Vision therapy: ocular motor training; 2020sep; 88 (3): 453-461
[5] Murray NP, Mesagno C; Eye movement differences in contact versus non contact Olympic athletes; 2024; 56 (6): 752-759
[6] Singla S, Prabhakar V, Singla RK. Role of transcutaneous electric nerve stimulation in the management of trigeminal neuralgia. J Neurosci Rural Pract.2011 Jul; 2 (2): 150-2. doi: 10.4103/0976-3147.83580. PMID: 21897677; PMCID: PMC3159350.
[7] Lee YC, Chueng YC, Hsu SW, Lui CC. Idiopathic hypertrophic cranial pachymeningitis: case report with 7 years of imaging follow-up. AJNR Am J Neuroradiol.2003 Jan; 24 (1): 119-23. PMID: 12533339; PMCID: PMC8148956.
[8] Araújo Melo LL, Daher MT, Gonçalves MVM, Freitas MB. Idiopathic Hypertrophic Spinal Pachymeningitis: A Case Report. Rev Bras Ortop (Sao Paulo).2021 Aug 13; 57 (3): 521-523. doi: 10.1055/s-0041-1724087. PMID: 35785110; PMCID: PMC9246536.
[9] Nguyen TT, Kang JJ, Chae JH, Lee E, Kim HJ, Kim JS, Oh SY. Oculomotor fatigability with decrements of saccade and smooth pursuit for diagnosis of myasthenia gravis. J Neurol.2023 May; 270 (5): 2743-2755. doi: 10.1007/s00415-023-11611-7. Epub 2023 Mar 1. PMID: 36856847; PMCID: PMC10129983.
[10] Murray NP, Hunfalvay M, Roberts CM, Tyagi A, Whittaker J, Noel C. Oculomotor Training for Poor Saccades Improves Functional Vision Scores and Neurobehavioral Symptoms. Arch Rehabil Res Clin Transl.2021 Mar 31; 3 (2): 100126. doi: 10.1016/j.arrct.2021.100126. PMID: 34179762; PMCID: PMC8212010.
[11] Caldani S, Delorme R, Moscoso A, Septier M, Acquaviva E, Bucci MP. Improvement of Pursuit Eye Movement Alterations after Short Visuo-Attentional Training in ADHD. Brain Sci.2020 Nov 4; 10 (11): 816. doi: 10.3390/brainsci10110816. PMID: 33158057; PMCID: PMC7694101.
[12] Jockusch J, Hahnel S, Sobotta BBAJ, Nitschke I. The Effect of a Masticatory Muscle Training Program on Chewing Efficiency and Bite Force in People with Dementia. Int J Environ Res Public Health.2022 Mar 22; 19 (7): 3778. doi: 10.3390/ijerph19073778. PMID: 35409460; PMCID: PMC8997984.