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Case Report/Olgu Sunumu

NEURODYNAMIC MOBILIZATION APPLICATION IN DROP FOOT: A PEDIATRIC CASE REPORT

DÜŞÜK AYAKTA NÖRODİNAMİK MOBİLİZASYON UYGULAMASI: PEDİATRİK OLGU SUNUMU

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ABSTRACT

Drop foot is characterized by the inability to lift the foot at the ankle. It is a common symptom in neurological conditions and can also result from orthopedic trauma. Neurodynamic mobilizations are techniques that involve sliding the nerves to alleviate nerve tension. There is limited literature on the use of neurodynamic mobilizations in pediatric patients. A four-year-old female patient presented with a drop foot to Kırşehir Ahi Evran University Physical Therapy and Rehabilitation Hospital. The main finding was that she dragged her foot on the ground while walking. This finding was confirmed by electromyography (EMG) testing of the deep peroneal nerve. In addition, loss of function was assessed with the Stanmore Assessment Questionnaire, loss of motor movement was assessed with the manual muscle strength test, and loss of sensation was assessed with the pinprick test and cotton wool. Electrical stimulation (EMS), passive mobilization of the peroneal nerve using neurodynamic techniques, and terminal knee extension with a resistant band and kinesiotape were applied. The pre-treatment score of 24 (poor) increased to 90 (good) after treatment. This study showed that a physiotherapy and rehabilitation program including passive neurodynamic mobilizations applied to the peroneal nerve increased functionality in a pediatric patient with foot drop.

ÖZET

Düşük ayak, ayağın ayak bileğinden kaldırılamaması ile karakterizedir. Nörolojik durumlarda yaygın bir semptomdur ve ortopedik travmadan da kaynaklanabilir. Nörodinamik mobilizasyonlar, sinir gerginliğini hafifletmek için sinirlerin kaydırılmasını içeren tekniklerdir. Nörodinamik mobilizasyonların pediatrik hastalarda kullanımına ilişkin sınırlı sayıda literatür bulunmaktadır. Dört yaşında kız hasta Kırşehir Ahi Evran Üniversitesi Fizik Tedavi ve Rehabilitasyon Hastanesi'ne ayak düşmesi ile başvurdu. Hastanın ana bulgusu yürürken ayağını yerde sürüklemesiydi. Bu bulgu derin peroneal sinirin elektromiyografi (EMG) testi ile doğrulandı. Ayrıca, Fonksiyon kaybı Stanmore Değerlendirme Anketi ile, motor hareket kaybı manuel kas gücü testi ile, duyu kaybı pinprick testi ve pamuk ile değerlendirildi. Elektrik stimülasyonu (EMS), nörodinamik teknikler kullanılarak peroneal sinirin pasif mobilizasyonu, direnç bandı ile terminal diz ekstansiyonu ve kinezyobant ile tibialis anterior kasına taktil uyarı uygulandı. Tedavi öncesi 24 (kötü) olan skor, tedavi sonrasında 90'a (iyi) yükselmiştir. Bu çalışma, peroneal sinire uygulanan pasif nörodinamik mobilizasyonları içeren bir fizyoterapi ve rehabilitasyon programının düşük ayağa sahip pediatrik hastada fonksiyonelliği arttırdığını göstermiştir.

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INTRODUCTION

Foot drop, the inability to lift the foot at the ankle, is a common symptom in neurological conditions such as stroke and multiple sclerosis. However, it can also result from orthopaedic trauma (Graham, 2010). The condition affects the dorsiflexors, namely the tibialis anterior, extensor hallucis longus, and extensor digitorum longus, along with the nerves primarily supplied by the common peroneal nerve (Villafañe et al., 2013). Although anterior horn cell disease, L5 radiculopathy, or partial sciatic neuropathy can contribute to foot drop, the primary cause is external pressure (Chrzanowska et al., 2023). This neuropathy can be caused by pressure from habitual crossing of the legs, prolonged squatting, the operating position during dental surgery or prolonged bed rest (Stewart, 2008). However, there is no record of a drop foot problem in a pediatric patient after dental surgery in the literature.

Neurodynamic Mobilizations (NM), as described by Butler (Butler, 2005), involve nerve sliding through the mobilization and positioning of various joints to alleviate tension on the nerves (Coppieters et al., 2009). Increased movement between the nerve and surrounding tissues can encourage the movement of fluid within the nerve and enhance its mobility, which may reduce symptoms (Gilbert et al., 2015). Another study reported that neurodynamic mobilizations have the potential to increase nerve conduction and blood flow (Ha et al., 2012). Villafane et al. found that a treatment program combining spinal and fibular head manipulation with neurodynamic mobilization led to pain reduction, increased range of motion and strength, and full function restoration in a patient suffering from severe dysfunction due to a compressed left common peroneal nerve (Villafañe et al., 2013). This case study aims to assess the effectiveness of NMs in addressing drop foot in a pediatric patient.

MATERIAL AND METHOD

Case

A four-year-old female patient was applied to Kırşehir Ahi Evran University Physical Therapy and Rehabilitation Hospital with a drop foot problem. Although there are no records of any injuries, diabetes, or alcohol abuse, the family stated that she developed the condition post-dental surgery. The surgery was for fractures in the central incisors and caries in the premolar-molar teeth and lasted two and a half hours. The patient was operated on under sedation, in a sitting position and no fixation device was used according to family. The day after surgery, the family noticed that she was dragging her foot on the floor while walking. Magnetic resonance imaging (MRI) and electroencephalogram (EEG) were performed. EEG analysis showed normal signal characteristics in the medulla oblongata, pons and mesencephalon, and no space-occupying lesions were found in the bilateral cerebellar hemispheres. MRI revealed a normal craniovertebral junction and no evidence of disc herniation. (Table 1) During the observational gait analysis, it was noted that the participant was unable to perform active dorsi flexion movement and walked by dragging her right foot on the ground. The family's primary concern was determining whether this issue was temporary and if so, ensuring their child's prompt return to school. The patient hoped to wear her right shoe again and play with friends during recess, but her orthotics prevented her from doing so.

Table 1

Timeline of Events related to Patient Treatment

Events	Date
Dental Surgery	11.12.2023
Magnetic Resonans Imaging (MRI)	11.15.2023
Electromyography (EMG)	11.16.2023
Electroencephlaography (EEG)	11.17.2023
Applying for the hospital	11.22.2023
Rehabilitation in clinic	11.29.2023–12.28.2023
Discharged	12.30.2023

Data Collection

The diagnosis was confirmed by a neurologist using electromyography (EMG) on the third day of clinical onset. The amplitudes and conduction velocities of the motor and sensory nerves examined in the bilateral lower extremities were within normal limits. However, the amplitude of the compound muscle action potential (CMAP) was lower in the right peroneal nerve compared to the left. Needle EMG of the studied muscles showed no significant pathological findings. Electrophysiological findings showed partial axonal degeneration in the motor branch of the right peroneal nerve. However, axonotmesis and neurotmesis could not be differentiated in this period. Therefore, an electrophysiologic examination after two weeks was recommended. However, the family did not attend the EMG evaluation two weeks later because the hospital where the initial evaluation was performed was located 2.5 hours away.

Absence of contraction of the tibialis anterior muscle was noted in a manual strength test (0/5). The evaluation of the function of the foot was carried out using the Stanmore Assessment Questionnaire (Lingaiah et al., 2018). Sensation was assessed with a pinprick test on the lateral side of the leg just distal to the knee for the common peroneal nerve, on the anterolateral distal third of the leg and most of the dorsum of the foot (except the first plantar region) for the superficial peroneal nerve, and on the first dorsal plantar region for the deep peroneal nerve (Apok et al., 2011). In the pin-prick test, the therapist gently touches the needle or its back end to the skin and asks the patient whether the needle is sharp or blunt. Light touch was tested by touching a piece of cotton to an area of skin. Both tests started distally and then progressed proximally (Nelson & Blauvelt, 2015). Assessments were repeated at the end of treatment, four weeks after the initial assessment.

Therapeutic Intervention

Before starting the treatment, the patient's family was informed about the potential benefits and potential side effects of neurodynamic mobilization (e.g. sensory impairment) and a signed Informed Consent Form was obtained. Electrical stimulation (EMS) was applied for 15 minutes using two pads placed distal and proximal to the tibialis anterior in the prone position with the knee flexed in a position where gravity facilitates dorsiflexion. Intermittent EMS current was applied for 5 seconds on and 3 seconds off with a minimum of 4 mA and a maximum of 12 mA. Based on the patient's feedback, the first contraction seen in the muscle and the current level that did not disturb the patient was determined to be a maximum of 12 mA (Xu et al., 2021). The patient performed a terminal knee extension exercise that involved both concentric and eccentric phases using a resistive band. The physiotherapist stood behind the patient and resisted knee extension with the band. The patient was instructed to squat slowly and stand up with the support of the chair. This movement was performed 3 times 10 repetitions with 1 minute rest in between. The movement allowed for eccentric control by the tibialis anterior. Tactile sensory input was manually applied to the motor point of the muscle to increase muscle activation.

Passive mobilization of the peroneal nerve using NMs was performed in three sets of ten repetitions (each set consisting of 2 s slide, 3 s rest) (Butler, 2005). The technique involved raising the right leg straight and rotating it inward with medial rotation of the hip while the patient was lying supine on the bed. The patient was then asked to laterally flex the trunk to the same side (Fig. 1). The second technique involved flexing the hip and knee in the same position as described above, while performing plantar flexion and inversion of the ankle with knee extension. Additionally, the patient was instructed to touch her chin on the trunk (Fig. 2). The third technique consisted of a combination of mobilization of the superior tibiofibular joint in a long sitting position, along with knee extension and spinal flexion (Fig. 3).

At the end of the session, kinesiotape was applied in an I-shape along the tibialis anterior at 25% tension (Özmen et al., 2017). Two weeks later, the patient started to move the dorsiflexors voluntarily in the side lying position (2/5). Therefore, we included active-assistive dorsi flexion movement in the treatment program and used taping on the tibialis anterior muscle for 3 sets of 10 repetitions with 30 seconds of rest. Given that there was a lower current intensity contraction in the patient's extensor digitorum brevis muscle, we reduced the maximum setting of electrical stimulation applied with EMS from 12mA to 9mA. Neurodynamic mobilizations were continued. Furthermore, a passive ankle-foot orthosis (PAFO) was recommended to prevent tripping and falling during walking.

At the end of three weeks, the patient's tibialis anterior muscle strength had increased to 3. We discontinued the use of EMS and emphasized the training of active dorsi flexion movements with minimal resistance (applied over the foot with the hand) were started to be practiced 3 times with 10 repetitions (30 seconds rest). Our patient stated that she no longer wears orthotics at home and can walk comfortably. However, she was advised to continue using it outside the home because it may cause balance problems and falls.

Figure 1

NM first set

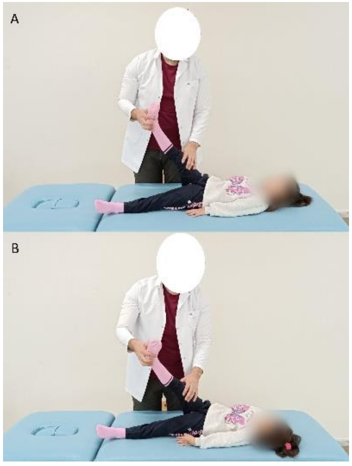


Figure 2

NM second set

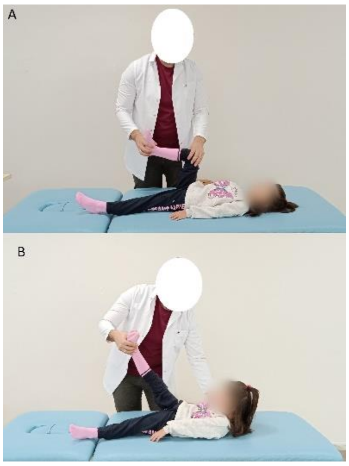
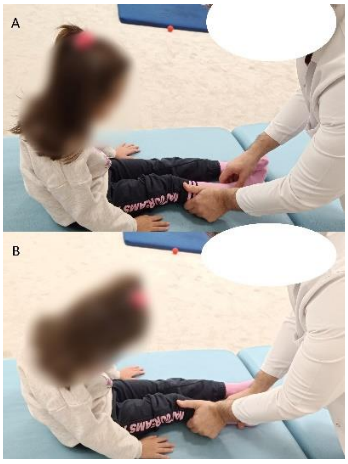


Figure 3

NM third set



Limitation of the Study

This study has several limitations. First, because it is a case study, its applicability to similar conditions seen in other pediatric patients has not been tested. Secondly, it is insufficient to demonstrate the pure effect of mobilization because it was applied within the rehabilitation program. Thirdly, it does not include the long-term results of the patient.

Ethical Committee Approval

Before starting to research, written and verbal consent was obtained from the parents of the 4-year-old pediatric patient.

RESULTS

The patient fully complied with the treatment throughout the study and did not report any side effects. The rehabilitation program resulted in clinical improvements in all sub-parameters of the Stanmore Assessment Questionnaire except pain and foot posture (which were the same as baseline). All affected lower extremity muscles were retested at the completion of treatment and the tibialis anterior was 4/5. (Table 2)

In the EMG evaluation performed after 4-weeks, the patient's neurologist stated that the neuropathy had resolved. This finding was also confirmed by increased strength of the tibialis anterior muscle. In the sensory areas, the sensory loss that was present in the pin-prick test and light touch evaluation disappeared after treatment.

Adherence to the intervention and tolerability were evaluated using self-reporting, interviews, and observational methods. The participant was instructed to report their adherence to the intervention. Afterward, the participant presented us with a picture bearing the message "I love you very much." Face-to-face interviews with the family revealed their high level of satisfaction with the outcome. It was also observed observationally that the participant was very engaged in all her exercises and was very happy when she came to the clinic.

Table 2

Results of Stanmore Assessment Questionnaire after the Rehabilitation Program

Parameters	Pre-Treatment Point	Post-Treatment Point
Pain (max. 15 points)		
Never (15)		
Occasionally (10)	15	15
Sometimes (5)		
Serious pain (0)		
Need for orthosis (max. 15 points)		
No need (15)		
Rarely (once a week) (10)	0	15
Sometimes (twice a week) (5)		
Frequent (more than twice a week) (0)		
Ability to wear normal shoes (max. 5 points)		
Yes (5),		
Only special model (3)	0	5
No (0)		
Functions (max. 10 points)		
Normal daily activity and normal recreation (10)		
Normal daily activity and limited recreation (6)	3	10
Limited daily activity and limited recreation (3)		
Seriously limited daily activity and recreation (0)		
Degree of active dorsiflexion (max. 25 points)		
Grade 4-5 (25)		
Grade 4 (20)	0	20
Grade 3 (10)		
Grade 2 and lower (0)		
Degree of active dorsiflexion (max. 25 points)		
More than 6° (25)		
0-5° (20)		
–5 / –1 ° (10)	0	25
–10 / –6° (5)		
Less than -11° (0)		
Foot posture (max. 5 points)	5	5
Plantigrade, balanced, no deformity (5)		
Plantigrade; mild deformity (3)		
Obvious deformity, misalignment (0)		
Total*	24 (Poor)	90 (Very Good)

*100-85 points: Very good, 84-70 points: Good, 69-55 points: Fair, <55 points: Poor

DISCUSSION

In this study, the effect of neurodynamic mobilizations on a 4-year-old girl's foot drop problem after dental surgery was investigated. The etiology of foot drop ranges from various diseases to mechanical injuries and includes neuropathy of the peroneal nerve. Yilmaz et al. conducted a case study that observed postural bilateral peroneal nerve involvement in one patient due to prolonged squatting and mechanically induced peroneal nerve involvement in two other patients (Yılmaz et al., 2004). The authors concluded that if there is clinical and electrophysiologic evidence of nerve damage, conservative treatment with EMG monitoring for three months should be preferred, and surgical decompression with a meticulous approach should be used in unsuccessful cases. In the literature, optimizing the care of patients with foot drop can be achieved through interdisciplinary collaboration among the specialists involved. The goal of treatment should always be to increase daily mobility (Carolus et al., 2019).

Dental treatments often involve invasive procedures in the oral cavity, carrying inherent risks of significant harm. Patients with uncontrolled, impulsive, or aggressive behavior may pose a threat to themselves and dental staff (Chen et al., 2014). In such cases, the papoose board is used as a sensory adaptation tool to provide deep touch pressure, stabilizing and calming patients, especially those with special needs or pediatric patients experiencing anxiety. While some parents report positive outcomes, noting the board's assistance in completing procedures and reducing stress for their children, others find it traumatizing, leading to feelings of guilt and anger towards dentists who use it without adequate consideration (Malik et al., 2022). Careful application of immobilization devices like papoose boards is crucial to prevent potential issues such as airway obstruction or chest restriction (Coté et al., 2006). If used, it's essential to keep a hand or foot exposed, and the child should never be left unattended. Additionally, the use of physical restraint devices like the papoose board may be seen as traumatic and outdated, considering evolving care standards and the availability of alternative techniques (Weaver, 2010). In this case report, the family stated that the child was in a sitting position during dental surgery and was removed from the operating room after sedation. The surgeon could not be reached about this issue, but it is possible that the immobilization device may have been used during surgery and if not, there may have been a trauma during surgery.

NM techniques are used to treat unfavorable neurodynamic conditions. The aim of these techniques is to reduce physical pressure on nerves (Shacklock, 1995). NM is believed to facilitate relative motion between nerves and adjacent tissues, reduce nerve adhesion, aid in the diffusion of noxious fluids, and improve neural vascularity (Scrimshaw & Maher, 2001). NM is believed to facilitate relative motion between nerves and adjacent tissues, reduce nerve adhesion, aid in the diffusion of noxious fluids, and improve neural vascularity. The use of proprioceptive neuromuscular facilitation to mobilize the neurodynamic system resulted in improvements in pain, nerve mobility, and balance. This approach had positive effects by increasing oxygen supply to the nerves and restoring altered movement patterns, ultimately improving the patient's activities of daily living (Jeanbart & Tanner-Bräm, 2021). The ability of NMs, such as stretching and sliding techniques, to decrease intraneural swelling in the upper extremity, particularly the median nerve (Boudier-Revéret et al., 2017). In another study, neurodynamic mobilization of the median nerve was reported to be effective for functional recovery of the upper extremity in tetraplegic patients (Saxena et al., 2021). Our study suggests that neurodynamic mobilizations can reduce intraneural edema resulting from intraoperative positioning or trauma-induced nerve injury. This is supported by our observation of functional improvement in our patient after treatment. The patient was able to resume normal daily and recreational activities, wear shoes without orthotics, and showed improvement in ankle range of motion and muscle strength parameters. Furthermore, the patient's emotional state improved upon achieving voluntary contractions. The patient also reported an increased ability to interact with peers at school and a greater willingness to participate in games.

CONCLUSION

Peroneal neuropathy resulting in foot drop is a rare condition in pediatric patients after dental surgery. Early diagnosis of foot drop is crucial in preventing serious functional impairment. A thorough history and examination can guide targeted investigations and management. Treatment options are determined by the underlying cause, but initial interventions typically include ankle-foot orthosis and physical therapy. Surgery and decompression of the common peroneal nerve may be considered for patients who do not respond to these treatments. This study shows that neurodynamic mobilizations have a positive impact on functional recovery in a pediatric patient with drop foot.

ETHICAL COMMITTEE APPROVAL

Written and verbal consent was obtained from the parents of the 4-year-old pediatric patient.

AUTHOR CONTRIBUTION

Idea/concept: ÖFÖ, AT; Design: ÖFÖ, AT; Consultancy: ÖFÖ, AT; Data collection: ÖFÖ, AT; Data Processing: ÖFÖ, AT; Analysis and/or Interpretation: ÖFÖ, AT; Literature review: ÖFÖ, AT; Writing of the article: ÖFÖ, AT; Critical review: ÖFÖ, AT

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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PEER REVIEWED

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