Journal of Modern Rehabilitation

Case Report

Resistance Training in Wilson Disease: A Case Study

Zahra Chakeri[1*], **Saeed Talebian**[2]

1. Department of Physical Therapy, Faculty of Rehabilitation, Tabriz University of Medical Sciences, Tabriz, Iran.
2. Department of Physiotherapy, School of Rehabilitation, Tehran University of Medical Sciences, Tehran, Iran.

Use your device to scan and read the article online

Citation: Chakeri Z, Talebian S. Resistance Training in Wilson Disease: A Case Study. Journal of Modern Rehabilitation. 2023; 17(2):212-218. https://doi.org/10.18502/jmr.v17i2.12419

https://doi.org/10.18502/jmr.v17i2.12419

Article info:
Received: 19 Aug 2021
Accepted: 7 Dec 2021
Available Online: 01 Apr 2023

Keywords:
Wilson disease; Upper extremity; Resistance training

ABSTRACT

A 15-year-old boy was diagnosed with Wilson disease and referred to a physiotherapy clinic for treatment. He received daily physical therapy exercises with resistance training three times a week for 70 minutes for 8 weeks. The performance of daily activities was evaluated using the Persian version of the disabilities of the arm, shoulder, and hand (DASH) questionnaire. Upper limb muscle strength was assessed using a manual muscle strength test. The DASH questionnaire score decreased from 67.24 before treatment to 46.55 after 4 weeks and 36.20 after 8 weeks. In addition, shoulder flexion and extension are improved. The analysis of resistance exercises to facilitate distal muscles through the use of manual muscle tests showed an improvement in the strength of both hands. The present study suggests that regular physical therapy and exercise may help improve daily activity and muscle strength in Wilson disease.

*** Corresponding Author:**
Zahra Chakeri
Address: *Department of Physical Therapy, Faculty of Rehabilitation, Tabriz University of Medical Sciences, Tabriz, Iran.*
Tel: *+98 (914) 1590104*
E-mail: *z.chakeri@gmail.com*

1. Introduction

Wilson's disease is a rare and autosomal recessive pathology, in which copper accumulates abnormally in the body, mainly affecting organs such as the liver, brain, and eyes [1, 2]. The prevalence of Wilson disease is approximately 1 in 30000, with men and women being affected equally [3]. Multiorganic damage leads to rapid deterioration of body functions and major psychological and neurological effects [4]. Wilson disease occurs when both parents pass on the abnormal gene responsible for the disease. When a single gene is involved, the patient is only a carrier and shows no symptoms [4, 5]. The disease is responsible for the ATP7B gene on chromosome 13. Mutations in this gene inhibit the proper functioning of ATPaza2 and are manifested by abnormal copper metabolism, and its clinical consequences range from asymptomatic to severe hepatic failure and chronic liver disease with or without cirrhosis [4, 5]. It is necessary to distinguish between this disease and diseases such as viral cirrhosis, sindenha or hangtington chorea, Gilles de Tourette, Neuroacanthosis, biliary cholangitis, heavy metal poisoning, and cerebral palsy, which can be a source of misdiagnosis [6].

In the diagnosis of this disease, blood and urine tests show low levels of ceruloplasmin (plasma protein that carries copper to the blood) and high levels of urinary copper, increased transaminases, coagulation disorders, and hypoglycemia [6]. In many Wilson patients, there are Kayser-Fleischer rings on the iris that are detected by an ophthalmologist or seen as a circular brown spot in the large iris area [4].

Screening in the first and the second relatives is mandatory for diagnosis. The disease is potentially treatable and treatment should begin after diagnosis. Treatment strategies include chelators such as D-penicillamine and Trientine [2], while zinc salts act as metallothinoin inducers and contribute to the negative balance of copper, reducing free copper in plasma, and improving symptoms. Different types of symptoms have been reported that vary depending on gender, genital involvement (menstrual disorders, amenorrhea), kidney stones, nephron damage, osteoarthritis, osteoporosis, and osteophytosis [7].

Liver damage begins around the age of six and progresses, so the first case appears in middle or true adolescence, around the age of 20 [4]. A neurological disorder is another cause of Wilson disease, seen as the first manifestation of disease or liver damage [8]. Accumulation of copper in brain tissue shows symptoms such as tremors, involuntary movements, dysarthria, dysphagia, speech disorders (tone of voice, speech or dysgraphia), balance, coordination, sleep and memory disorders, muscle spasm, and dystonia [4]. However, some cases have been diagnosed with severe nervousness such as tremors, dystonia, parkinsonism, and muscle cramps [2].

As a rare disease, few experiments have been performed in this area, especially on treatment strategies that the patient follows better and can ultimately be harmed. Therefore, it is associated with etiopathogenetic treatment [2]. For Wilson disease with limb neurological involvement, rehabilitation treatment is important to improve the life and function of the limbs and muscle strength.

Physiotherapy is a method that uses various forms of motor activity to improve function and maintain function or use it. This study aimed to treat the functional aspects of Wilson disease with methods that include daily physiotherapy and enhanced exercise therapy. In particular, we can analyze how 8 weeks of exercise therapy combined with drug therapy can improve mobility.

We reviewed physiotherapy and daily resistance training for upper limb function and muscle strength in a Wilson patient. Through this study, we plan to perform an experiment on a 15-year-old teenager with Wilson disease.

2. Materials and Methods

Case presentation

A 15-year-old male patient was diagnosed with neurological symptoms of Wilson disease (WD). In this case, he has no family history. In October 2020, the patient was treated for dysphagia and presentation of Brady Keynesian stiffness and gait disorders. Ten months ago, on 26 October 2020, magnetic resonance imaging (MRI) scans of the basal ganglia along with the Kaiser-Fleischer ring showed that the patient had been diagnosed with WD and had begun medical treatment.

Medications included trientine, Vitamins E and B, zinc plus, and D-penicillamine. General dystonia was seen with the expansion of the lower limbs, which was walking and, according to the patient, caused it to recur. The patient's medical team had difficulty initiating rehabilitation. The patient was treated under the strict supervision of a neurologist. Medications did not change from the time of diagnosis until the start of physiotherapy.

The patient was alert and directional, well supported by the family, and showed excellent knowledge of the illness and motivation to participate in rehabilitation. The movement starts from the distal and first the lower limb relative to the upper limb, then gradually engages the upper limb.

Whether the patient was prepared in the physiotherapy clinic, in the first stage, he showed independent walking without the help or assistance of others. At the time, upper limb involvement was more pronounced, with the patient unable to grasp and lift objects. The patient was right-handed and the left hand was weaker. The patient's upper limb function was assessed using the Persian version of the DASH limb function disability questionnaire. The validity of the DASH questionnaire for various questions was reported between 0.70-0.80 and 96% [9].

The muscle function was assessed using the manual muscle test (MMT). This method of testing muscle strength is reliable in different types of populations [10]. MMT was used according to the 8-point ordinal scale ranging from zero to five [11]. For example, the score -2 was converted to 1.5 and 3+ to 3.5. The left upper limb showed significant weakness, whereas the distal muscle groups were more damaged than the proximal muscles and the MMT was grade 2 or higher for the distal muscles.

The MMT to evaluate the strength of flexion, adduction, and abduction of the shoulder, extension, flexion of the elbow, extension, pronation, and supination of the wrist was performed [12].

After a thorough examination of the shoulder movement on all plates, the patient was placed in a short sitting position with his arm on either side, his elbow slightly bent, and his forearm pronated. To assess the strength of the shoulder flexors, the therapist stood next to the patient, placed his hand on the distal humours just above the elbow to exert force, and stabilized the shoulder with the other hand. The patient bends the shoulder up to 90° without rotation or horizontal movement.

For the assessment of shoulder abductor strength, the therapist stood behind the patient. The resistance of the hand was placed on the arm just above the elbow. The patient was asked to raise his arm from the sides to shoulder level and abduct his hand up to 90°.

For evaluation of the shoulder adductor strength, the patient rest in the supine position, and the elbow and shoulder were flexed at 90°.

For elbow flexors strength testing, the patient sat in a supine position with the arms on either side of the forearm in a supination position. The therapist's hand was placed on the forearm flexion surface near the wrist to resist. The other hand applied reciprocal force by placing the palm on the upper anterior surface of the shoulder.

To evaluate the elbow extensor strength, the patient was placed in a prone position, the arm was bent at a 90° abduction and forearm position, and hung vertically on the table. The therapist supported the top of the elbow and used the other hand to apply downward resistance to the dorsal surface of the forearm. The patient was asked to extend the elbow to the end of the range or as long as the forearm was lying horizontally on the ground.

To find out the wrist flexors strength, the patient sits in a short position with his forearm on the table and the forearm supinated. The wrist is in a neutral or slightly stretched position. The therapist supported the patient under the wrist with one hand and applied resistance to the palm of the other hand with the other hand.

To test the wrist extensor strength, the patient was placed in a short sitting position with the elbow bent, and the forearm completely pronated, and he was placed on the table. The wrist was in a neutral or slightly stretched position. The therapist supported the patient's forearm, the hand used for resistance resting on the dorsal surface of the metacarpals. The patient was asked to raise the wrist not allowing the therapist to push it down.

To assess forearm supinator strength, the patient sat down in the short sitting position, the arm was at the side and elbow up to 90°, and the forearm was placed in pronation. A therapist's hand applied resistance to the palmar surface of the wrist. The patient was asked to turn his palm up and hold it.

For assessment of the forearm pronation strength, the patient was placed in the short sitting position, and the elbow bent up to 90° in the supine position. A therapist's hand was placed on the dorsal surface of the wrist to provide resistance. The patient was asked to lower and hold the palm of his hand not allowing the therapist to rotate it [13].

A total score was calculated (24) for Lt and (27) for Rt as well as sub-scores for the muscle groups of the shoulder (8.5) for Lt and (9.5) for Rt, elbow (6) for Lt and (7) for Rt and wrist (9.5) for Lt and (10.5) for Rt.

Because the proximal muscles strongly affect the distal muscles, muscle activity of the proximal parts is required to activate the distal parts [14].

Nakhai et al. (2014) stated that activation of the muscles of the proximal parts is required for distal activities and the proximal muscle can be a stable and controlled base for distal activity. Natural development is believed to progress from proximal control to distal control. Since distal muscle weakness can be a major problem for the patient, it should be strengthened to increase performance and quality of daily activities [15].

The proximal muscles of the upper limb are located on the triceps, biceps, deltoid, pectoral, and axilla. Proximal muscle strengthening exercises were performed for the upper limbs, which included exercises with assistance, then active exercises, and then gradual resistance. He underwent 70 minutes of physiotherapy including 15 minutes of stretching, 40 minutes of resistance training, and then 15 stretchings and breathing three times a week for 8 weeks. The stretching program was applied during the warm-up for 5 minutes, which was preceded by jogging/aerobics for 3 minutes, arms stretch, back and leg stretch, full back dull, heel holding exercise, ankle holding stretch, arm leg and torso stretch, and foot touch exercises performed in the physical therapy clinic as much as possible without pain. Fourteen close muscle strengthening exercises including open chain movement (OKC) and closed chain movement (CKC), were performed to further strengthen muscle strength and proximal stability, i.e. the stability of the body's proximal joints, such as the shoulder joint. Prescribed exercises began with low repetitions (usually 5 to 10 repetitions) and short vigorous muscle sessions. The treatment that included exercises with assistance followed by active exercises and then progressively with resistance (manual, Thera-band, and weight) was applied as an analytical exercise on the muscles near the upper extremity for optimal effect on movement disorders (Table 1).

Exercise intensity was carefully monitored and physiotherapy was stopped before the patient reported the disease.

Resistance training continued 3 times a week for 8 weeks. Main exercises included exercises with assistance followed by active exercises and then progressive-

Table 1. Physiotherapy program

Warm Up 15 Min	**Stretching**				
			Beginning	**To 4 Weeks**	**To 8 Weeks**
Main exercises 40 min	Lowering	3 set with 10 repetition	Active	Active with manual resistance	Thera-band R
	Pulling		Active	Thera-band R	Thera-band G
	Shoulder press		Active	1 kg dumbbell	2 kg dumbbell
	Shoulder shrug		Active	1 kg dumbbell	2 kg dumbbell
	Wall slide		Active	Thera-band R	Thera-band G
	Scapular upward rotation		Active	Thera-band R	Thera-band G
	Diagonal 1 flexion		Active assistive	Active	Thera-band R
	Diagonal 2 flexion		Active assistive	Active	Active with manual resistance
	Diagonal 1 extension		Active	Active with manual resistance	Thera-band R
	Diagonal 2 extension		Active	Active with manual resistance	Thera-band R
	Shoulder abduction		Active assistive	Active	Thera-band R
	Shoulder Adduction		Active	Active with Thera-band R	Thera-band R
	Shoulder flexion		Active assistive	Active	Thera-band R
	Raise arm in the prone position		Active	Thera-band R	Thera-band R
Cool down for 15 min	Stretching and breathing				

JMR

ly with resistance by manual, weight, red thera-band (R), and green thera-band (G).

3. Results

The DASH questionnaire score decreased from 67.24 before treatment to 46.55 after 4 weeks and 36.20 after 8 weeks. In addition, shoulder flexion and extension were improved in the analysis of proximal strengthening exercises on the facilitation of distal muscles. The use of muscles showed a significant improvement in the strength of both hands (Table 2).

After 8 weeks total score was increased from 24 to 31 for Lt and from 27 to 32.5 for Rt. Also, the strength of subgroups for the muscle groups of the shoulder changed from 8.5 to 10.5 for Lt and from 9.5 to 11 for Rt, elbow from 6 to 7.5 for Lt and from 7 to 8 for Rt and wrist from 9.5 to 13 for Lt and from 10.5 to 13.5 for Rt (Table 2).

4. Discussion

Resistance training has a positive effect on movement disorders and improves tissue blood flow, which in turn provides better oxygen and metabolic needs. During the sessions, it was necessary to determine the patient's functional potential. Depending on the patient's clinical condition and function, there should be a favourable load. If you can be light (stimulation below the threshold), there is not enough to perform the physiological

Table 2. The disabilities of the arm, shoulder, and hand questionnaire score

	Scores	In Beginning		After 4 Weeks of Exercises		After 8 Weeks of Exercises	
DASH score	Doing daily activity			19 points for improvement in the performance of a daily activity		9 points for improvement in the performance of a daily activity	
	The severity of joint pain, weakness, tingling, and stiffness during sleep and activity			2-degree reduction in pain and weakness		2-degree reduction in tingling and weakness	
	The effect of upper extremity problems on the limitation of social activities and work			One degree reduction in limitation		No change	
	Feeling less capable, less self-confident, and not useful due to upper limb problems			Has changed from agree to neither agree nor disagree		Has changed from neither agree nor disagree to disagree	
	Total score	67.24		46.55		36.20	
MMT score	Muscle groups	Right	Left	Right	Left	Right	Left
	Shoulder flexion	3	2.5	3.5	3	4	4
	Shoulder abduction	3	2.5	3.5	3	4	3.5
	Shoulder adduction	3.5	3.5	3.5	3.5	3.5	3.5
	Elbow flexion	3.5	3	3.5	3	3.5	3
	Elbow extension	3.5	3	3.5	3.5	4	4
	Wrist flexion	3	2.5	3.5	3	4	3.5
	Wrist extension	2	2	3	3	3.5	3.5
	Wrist pronation	3	2.5	3	3	3	3
	Wrist supination	2.5	2.5	3	3	3	3

DASH: Disabilities of the arm, shoulder, and hand; MMT: Manual muscle test.

and therapeutic effect and vice versa. If you overdo it, there will be unwanted communication and nervous tension or quick side reactions in the body [14].

Regular use of physiotherapy requires the creation of a specific program that includes goals, tasks, and tools. Physiotherapy strength training should be done as usual using the desired effect to change the body's functional and motor response. You have to follow the solution according to the stage of the disease. The duration of physiotherapy also requires the type and severity of the disease. In addition, physiotherapy is an important part of optimally improving neurological symptoms in the Wilson disease. The goal of physiotherapy is to improve the disability and quality of life of people in need of the disease. Some previous studies have examined physiotherapy and motor function improvement in the case of Wilson syndrome.

The use of physiotherapy techniques is needed as soon as possible in the clinical stage. Our goal was to restore our functional status and management by normalizing the non-replacement of muscle and muscle tone and the stimulation of deep and external receptors to improve the senses and improve the natural mechanisms of the situation. It was enough for the patient to act confidently and independently in activities outside the home, and at the same time, intermittent follow-up was required.

The results showed that by default, after training, improvements were made and we can prepare our exercise method according to the stage of the disease. Because physiotherapy is used, the patient experiences the function of weak limbs. It was associated with the gradual strengthening of muscles and the improvement of daily functioning.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

All authors declare no conflict of interest.

Acknowledgments

The authors would like to thank the patient and his family for participating in the study.

References

[1] Scheiber IF, Brůha R, Dušek P. Pathogenesis of Wilson disease. Handbook of Clinical Neurology. 2017; 142:43-55. [DOI:10.1016/B978-0-444-63625-6.00005-7] [PMID]

[2] Van Nguyen H, Nguyen DN, Nguyen HT. A case of Wilson disease with the ATP7B mutation presenting movement disorders. Surgical Neurology International. 2021; 12. [DOI:10.25259/SNI_489_2021] [PMID] [PMCID]

[3] Rani R, Rathia S, Kori V, Patel K. Wilson'S disease with ayurvedic approch-a case study. International Ayurvedic Medical Journal, India. 2020; 4910-4917. [DOI:10.46607/iamj5708102020]

[4] Roman O.T. The effectiveness of cognitive-behaviour psychotherapy in Wilson's disease: Single subject experiment. Journal of Psychological and Educational Research. 2021; 29 (1):140-153. [Link]

[5] Collins CJ, Yi F, Dayuha R, Duong P, Horslen S, Camarata M, et al. Direct measurement of ATP7B peptides is highly effective in the diagnosis of Wilson disease. Gastroenterology. 2021; 160(7):2367-82. [DOI:10.1053/j.gastro.2021.02.052] [PMID] [PMCID]

[6] Kalita J, Kumar V, Chandra S, Kumar B, Misra UK. Worsening of Wilson disease following penicillamine therapy. European Neurology. 2014; 71(3-4):126-31. [DOI:10.1159/000355276] [PMID]

[7] Beinhardt S, Leiss W, Stättermayer AF, Graziadei I, Zoller H, Stauber R, et al. Long-term outcomes of patients with Wilson disease in a large Austrian cohort. Clinical Gastroenterology and Hepatology. 2014; 12(4):683-9. [DOI:10.1016/j.cgh.2013.09.025] [PMID]

[8] Huster D, Kühne A, Bhattacharjee A, Raines L, Jantsch V, Noe J, et al. Diverse functional properties of Wilson disease ATP7B variants. Gastroenterology. 2012; 142(4):947-56. [DOI:10.1053/j.gastro.2011.12.048] [PMID] [PMCID]

[9] Mousavi SJ, Parnianpour M, Abedi M, Askary-Ashtiani A, Karimi A, Khorsandi A, et al. Cultural adaptation and validation of the Persian version of the disabilities of the arm, shoulder and hand (DASH) outcome measure. Clinical Rehabilitation. 2008; 22(8):749-57. [DOI:10.1177/0269215508085821] [PMID]

[10] Cuthbert SC, Goodheart Jr GJ. On the reliability and validity of manual muscle testing: A literature review. Chiropractic & Osteopathy. 2007; 15(1):4. [DOI:10.1186/1746-1340-15-4] [PMID] [PMCID]

[11] Hislop HJ, Montgomery J. Daniels and Worthingham's muscle testing: Techniques of manual examination. Amsterdam: Saunders/Elsevier; 2007. [Link]

[12] Klingels K, De Cock P, Molenaers G, Desloovere K, Huenaerts C, Jaspers E, et al. Upper limb motor and sensory impairments in children with hemiplegic cerebral palsy. Can they be measured reliably? Disability and Rehabilitation. 2010; 32(5):409-16. [DOI:10.3109/09638280903171469] [PMID]

[13] Brown B, Avers D, Daniels and Worthingham's muscle testing: Techniques of manual examination and performance testing. Amsterdam: Elsevier; 2018. [Link]

[14] Vispute A R, Kanase SB. Effect of proximal muscle strengthening on distal muscle facilitation in guillain barre syndrome. Journal of Evolution of Medical and Dental Sciences. 2020; 9 (37):2741-5. [DOI:10.14260/jemds/2020/595]

[15] Nakhaie N, Nodehi-Moghadam A, Bakhshi E, Goghatin Alibazi R. Activation of shoulder girdle muscles during gripping task: A systematic review of literature. Physical Treatments-Specific Physical Therapy Journal. 2014; 4(1):3-8. [Link]