

Effectiveness Of Modified Dynamic Wrist Hand Orthosis In Treatment Of Ulnar Deviation For Patients With Rheumatoid Arthritis On Grip Strength & Hand Function.

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Abstract- Background: Rheumatoid arthritis (RA) is a chronic inflammatory disease that affects the hand joints and leading to impairment in hand function and reduce grip strength. Rheumatoid arthritis mostly affects small joints resulting in structural damage of metacarpophalangeal joint (MCP) resulting in ulnar deviation. Orthosis are designed to maintain the hand function but mostly the resting hand orthoses which are available hinders the activities of daily living. Hence, a modified dynamic wrist hand orthosis was designed keeping in mind that it does not restrict any activity and is helpful in correcting the alignment of hand by restoring biomechanical balance and reducing tissue stress thereby improving grip strength and hand function of patients with rheumatoid arthritis.

Aim and objective: The present study shows the effectiveness of modified dynamic wrist hand orthosis on hand functions and grip strength for the treatment of ulnar deviation resulting due to rheumatoid arthritis.

Methodology: A sample of 19 rheumatoid arthritis subjects having ulnar deviation hand deformity was collected from rheumatology department of Indian spinal injuries center after clearance from Institutional Ethics Committee. In this study data was collected by non-probability convenience sampling technique as per the inclusion criteria. Pre-test data of grip strength and hand function of subjects willing to participate in the study was collected. The treatment of modified dynamic wrist hand orthosis was given to all the subjects for a period of one week. Post-test data of grip strength and hand functions of same subjects was collected with the subjects wearing the orthosis after the completion of intervention period.

Result: Data recorded was analyzed using SPSS data analysis software. A paired t- test was used to compare the difference between pre-test and post-test data of grip strength and hand function. It was found that there was a significant improvement in grip strength and hand function score after the intervention of modified dynamic wrist hand orthosis.

Conclusion: The finding of the study indicates that there was significant improvement observed with the use of modified dynamic wrist hand orthosis in terms of hand function and grip strength. Therefore, it can be concluded that modified dynamic wrist hand orthosis can be an effective treatment for patients with ulnar deviation due to Rheumatoid arthritis.

Index Terms- Rheumatoid arthritis, ulnar deviated hand Modified dynamic wrist hand orthosis, grip strength and hand function.

I. INTRODUCTION

Rheumatoid arthritis (RA) is a chronic inflammatory disease that affects the hand joints and further leads to impairment in hand function and reduces grip strength.¹

RA affects 0.5% of people worldwide.² According to estimations, ulnar deviation affects 45% of Rheumatoid arthritis patients who have disease for more than 5 years.³

Rheumatoid arthritis mostly affects small joints resulting in structural damage that further causes disruption at metacarpophalangeal joint leading to ulnar deviation.⁴

Metacarpophalangeal joint synovitis causes metacarpal head destruction, attenuation of the joint capsule and radial collateral ligaments, and proximal phalanx dislocation. The extensor and flexor tendons are displaced in a volar direction, and the ulnar intrinsic muscles contract. Wrist Synovitis frequently causes carpal translocation with radial inclination of the metacarpals and compensatory ulnar deviation (UD) of the fingers, characterized as the zigzag deformity. Finally, forces applied to the fingers during grasping tend to

displace them in an ulnar orientation, contributing to the deformity. Metacarpophalangeal (MCP) ulnar drift (UD) is a common consequence of rheumatoid arthritis (RA).³

In case of upper limb splinting, orthoses were created to help people keep their hands working by correcting joint alignment, restoring biomechanical balance, and lowering stress on tissues.³ Orthoses are external devices that are put to a body segment to provide support to joints and provide the greatest alignment possible.⁵

Night splints are commonly used to keep the hand in a resting position, providing joint protection in RA patients.⁵

Hand resting splints and functional MCP splints are often utilized in the conservative management of ulnar deviation deformity. They are also utilized to minimize the risk of intrinsic and extrinsic flexor contractures in end-stage RA hands.⁶

There are studies depicting resting splints are used to relieve hand and wrist pain, reduce swelling and inflammation, reduce, or prevent deformity, and improve hand function.¹⁵

Another variant of orthosis for RA with MCP joint involvement is functional MCP splints. These are indicated for mild synovitis and/or early-to-moderate soft tissue alterations. The splint holds the MCPJs in mild flexion and neutral deviation. Its goals are to relieve discomfort, reduce flexion force during grasp, reposition the fingers to improve pinch, and prevent the intrinsic-plus posture. For optimal hand function, the splint should only cover the affected joints. The splint is intended to reduce deforming stresses on the periarticular structures and to avoid excessive hand and wrist flexion.^{2, 6}

According to literatures there are fewer studies available on orthosis/splints for RA with which patients can perform any activity. This often leads individuals to adapt their daily activities or stop doing different hobbies and activities altogether. Use of the resting splint had a low compliance rate in RA patients. In Rheumatoid Arthritis, hand deformities like ulnar deviation and finger deformities tend to develop early in the disease process and have a significant effect on grip strength and hand function.² Since grip strength and hand function are very important parameters in RA, therefore there is a need to evaluate and ascertain the effects of dynamic functional wrist hand orthosis on these parameters in patients which can be prescribed as an effective treatment protocol of RA population. As there are limited studies available with this type of intervention. Therefore, there was a need to develop splint which does not restrict in activities of daily living and provides improvement in alignment so that patients with RA can be benefited in all aspects majorly grip strength and hand function.

Hence, modified dynamic wrist hand orthosis was developed which can be worn by patients with the ease of donning & doffing without causing any major restrictions in activities of daily living (ADL) so that hand function of patient in ulnar deviation with rheumatoid arthritis can be improved. This orthosis was also designed to be cosmetically acceptable along with improving hand functions of the patient.

Therefore, the purpose of this study was to find the effectiveness of modified dynamic wrist hand orthosis among patients in treatment of ulnar deviation with Rheumatoid arthritis on hand function and grip strength.

II. METHODOLOGY:

The research team developed a modified dynamic wrist hand orthosis keeping in mind that the splint does not restrict any activities of daily living and provide improvement in alignment of joints at MCP thereby correcting ulnar deviation.

Modified dynamic wrist hand orthosis is made up of low temperature thermoplastic, elastic strap and aluminum uprights that controls and prevents deformity and aids in maintaining anatomic alignment and to improve the hand functions. The elastic band/strap acted as the tension to align fingers from ulnar deviation. The orthosis is light weight and does not have complicated mechanism.



Figure 1: Modified dynamic wrist hand orthosis.

A sample size of 19 patients with rheumatoid arthritis between the ages of 35 to 55 years took part in the study after being selected according to the inclusion which included – patient with confirmed diagnosis of rheumatoid arthritis, patients having ulnar deviation due to RA, flexible ulnar deviation at MCP. Exclusion criteria included subjects– finger deformities i.e., swan neck deformities and boutonniere deformities, cognitive or psychological problems that could influence the study i. e. neurological deficits, subjects with hearing impairment, subjects with visual impairment, any musculoskeletal or neurological disorder affecting the upper limb, any injury affecting the hand, wrist or arm, any previous upper limb surgery, fixed contracture of upper extremity.

The subjects were chosen through non- probability convenient sampling technique.

Pre-test and post-test data of grip strength was collected using the Jamar hand dynamometer. When doing power grip strength tests, the right shoulder was relaxed and adducted, the elbow was flexed at 90 degrees, the forearm was in a neutral rotation, and the thumb was pointed upward. The wrist was in neutral radioulnar deviation with the fingers extended. The dynamometer was provided to the participant once they were in the beginning position, and they were instructed to maintain their strongest grip for three seconds. The position of the wrist in two anatomical planes when maximum grip strength was attained was also recorded to ascertain whether any restrictions in wrist motion with orthotic use could account for reduction in grip strength, if present. Prior to each test, participants received verbal signals, and they were also verbally prompted to exert their greatest grip strength at each point in the exercise.

Pre-test and post-test data of hand function was collected using the Jebsen hand function test. The Jebsen hand function test consists of seven subsets including writing, card turning, picking up small things, simulating feeding, stacking, picking up large lightweight objects, and picking up large heavy objects. The Jebsen hand function test requires 15 – 45 minutes to complete. No specific training was required. Each item is scored according to time taken to complete the task. Times were rounded to the nearest second. The scores for all 7 items were then summed for a total score. The patient's dominant hand was identified before beginning the JHFT.

III. PROCEDURE:

The subjects were recruited to participate in the study. According to the inclusion criteria the subjects were assessed and screened. The detailed information was given to the subjects about the procedure. Subjects consenting to participate in the study signed the consent form. Pre-test data of grip strength and hand function was collected without splint with the help of Jamar dynamometer and Jebsen hand function test respectively. The intervention of modified dynamic wrist hand orthosis was provided to each subject for a period of one week. The procedure of donning and doffing of the orthosis was explained to each subject.

Post-test data of grip strength and hand function was collected after the completion of intervention period by Jamar dynamometer and Jebsen hand function test respectively with patient wearing the modified dynamic wrist hand orthosis.

IV. DATA ANALYSIS:

Statistical Package for the Social Sciences (SPSS) was used to analyze the data collected.

Paired t-test was analyzed individually.

A paired t-test was used to do a comparison of pre and post intervention value of grip strength and hand function with and without orthotic intervention was done.

Comparison of pre and post intervention values of grip strength was done by Jamar dynamometer with and without the orthotic intervention.

Comparison of pre and post intervention values of hand function was done by Jebsen hand function test with and without orthotic intervention.

A significant level of $P < 0.05$ was fixed. RESULTS:

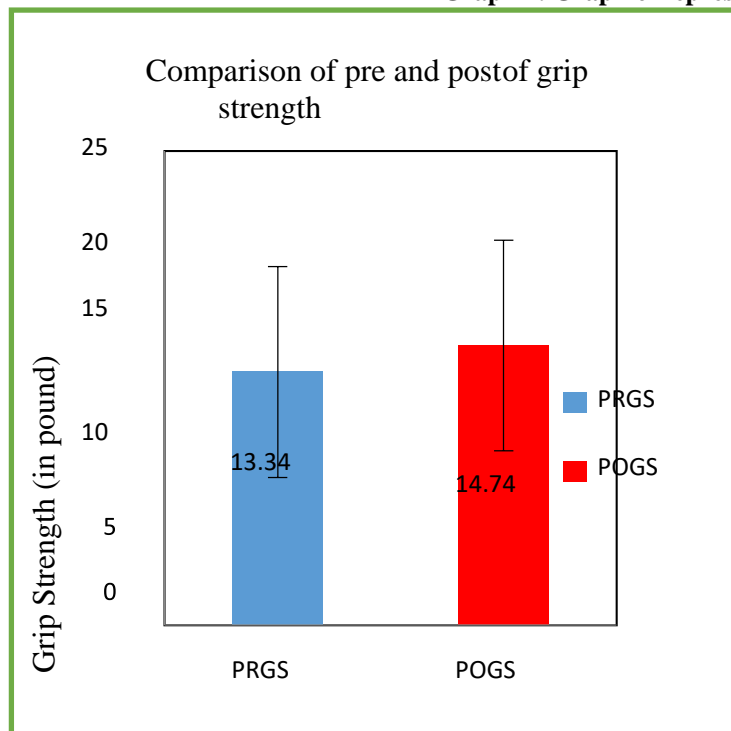
A total of 19 patients with Rheumatoid Arthritis having ulnar deviation participated in the study. Patients were given modified dynamic wrist hand orthosis. Paired t- test analyzed pre-test (mean = 13.34, S.D = 5.54) scores and post-test (mean=14.74, S.D = 5.55) scores of grip strength, tested using the Jamar hand dynamometer. It was found that there was significant difference in grip strength after using modified dynamic wrist hand orthosis t-value =6.614, p-value = 0.00). (Table 1) Simultaneously a paired t-test was also conducted to compare the results of hand function scores, tested using the Jebsen hand function test. The differences between the pre-test (mean=80.24, S. D=8.44) and post-test mean (78.09, S. SD=7.93), which indicated that there were significant differences in hand function scores after using modified dynamic wrist hand orthosis. (t-value = 5.79, p-value=0.00). (Table2)

Table 1: Paired T-Test Result of Grip strength Score

Grip strength (Dynamometer)	Mean \pm S.D.	t- value	p- value
PRGS	13.34 \pm 5.54	6.14	.000
POGS	14.74 \pm 5.55		

*Significant at 0.05 level S.D-Standard deviation

Graph 1: Graphic Representation of grip strength

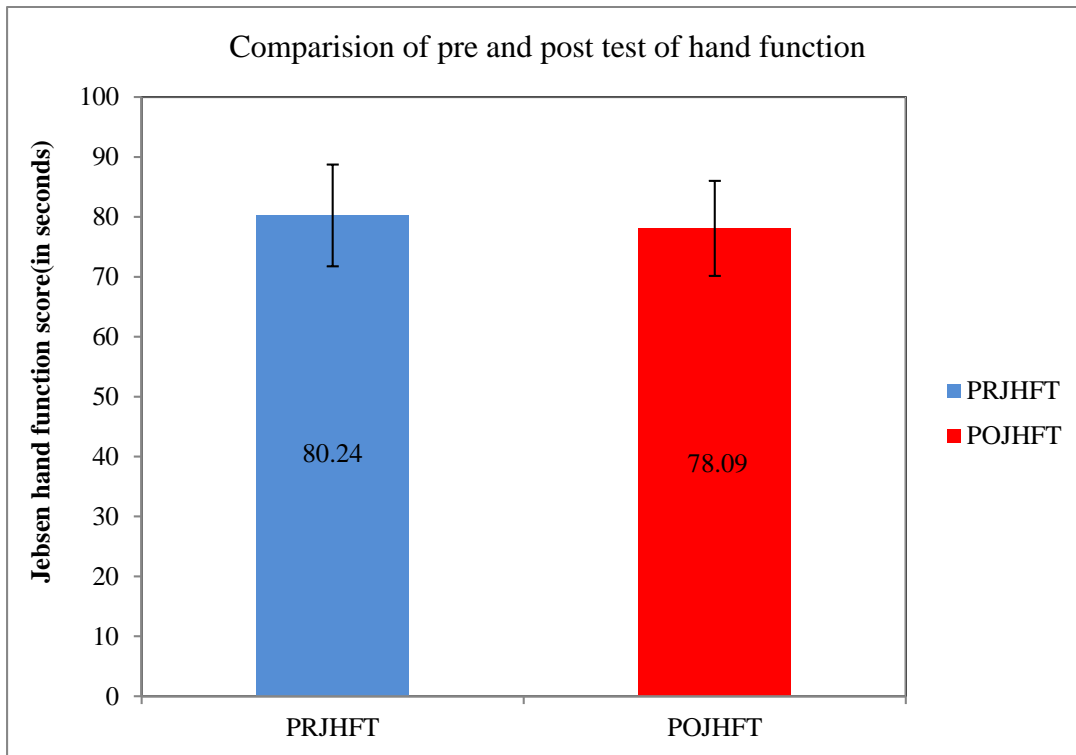


PRGS- Pre-test Grip strength
POGS- Post-test Grip strength

Table 2: Paired T-Test Results of Jebsen Hand Function Test

Hand function (JHFT)	Mean \pm S.D.	t- value	p - value
PRJHFT	80.24 \pm 8.49	2.921	0.009
POJHFT	78.09 \pm 7.93		

Graph2: Graphic representation of Jebsen Hand Function Test Score



PRJHFT - Pre-test Jebsen Hand Function Test
POJHFT- Post-test Jebsen Hand Function Test

V. DISCUSSION:

After reviewing the previous literature, it was discovered that Rheumatoid arthritis (RA) is an autoimmune disease linked to progressive disability, which impairs hand function. The most frequent hand deformity seen in RA patients is ulnar deviation.^{7, 14} The patient's grip strength and hand function are particularly at risk because of Rheumatoid arthritis.⁸ There are many orthotic options available to treat ulnar deviation conservatively, but some studies indicate that patients who wear hand splints while performing activities report that the splints are burdensome to wear, they limit the dexterity needed for some activities, cosmetically not appealing and they may deteriorate while being worn.⁹

Patients with rheumatoid arthritis (RA) are frequently advised to use splints or orthotics to reduce pain, minimize swelling, and/or avoid deformity. These orthoses include wrist supports, resting hand splints. Patients are typically told to wear the splints while engaging in activities, but most of the splints which are available make them feels hefty. That is why there was a need to design a splint which is less cumbersome.¹⁰ Study by Veehof et al., found that the splints used by patients in RA causes discomfort and restrict dexterity.¹

Therefore, the modified dynamic wrist hand orthosis was designed keeping in mind the patient can easily perform activity of daily living without much difficulty. Hence, the current study assesses the impact of a modified dynamic wrist-hand orthosis which is a light weighted dynamic splint not hindering any activities among subjects with RA having ulnar deviation on the parameters of grip strength and hand function which are most reduced in Rheumatoid arthritis.

The result of present study suggested that grip strength was improved from orthotic intervention of modified dynamic wrist hand orthosis with significant improvement in post – intervention grip strength score mean = 14.74 ± 5.55 , p- value = 0.00 as compared to pre – intervention score mean = 13.34 ± 5.54 which indicates significant improvement in grip strength. This is supported by earlier study done by Reza Yazdan et al, their result showed improvement in grip strength; outcome measures before the start of orthosis use = 8.7 ± 0.99 , after use of orthosis = 10.3 ± 1.5 & p-value = 0.004, which indicated significant improvement in grip strength after the use of orthosis in patients with RA.¹³ According to study by Santosh et al., hand diseases cause functional loss or limitation because of deformities, stiffness, insufficient strength, and improper finger alignment for pinching. The prehensile hand must be mobile, stable, and strong in order to function, and problems occur when any one of these three aspects of the working hand is compromise¹¹ therefore there is need of using splinting in Rheumatoid arthritis population.

In Rheumatoid arthritis, impaired hand function is prevalent. The effectiveness of wrist and hand splints in people with rheumatoid arthritis is a difficult proposition, according to the Cochrane review.⁶

Therefore, the present study also focused on changes in hand functions with splint and the result of present study suggested that hand function score was improved from orthotic intervention of modified dynamic wrist hand orthosis with a significant improvement

in post – intervention hand function score mean = 78.09 ± 7.93 , as compare to pre intervention score mean = 80.24 ± 8.49 which indicates significant improvement in hand function scores as the time required to accomplish the given tasks in Jebsen hand function test was significantly reduced as compared to the pre- readings of this test, which clearly indicates there was improvement in Jebsen hand function test. Present study shows that the use of modified dynamic wrist hand orthosis provides significant improvement in hand function and does not hinder fine motor tasks. This is supported by study done by Kumari R et al., suggesting that orthotic treatments may improve hand functional activities, pinch strength, and ADL related activities by reducing stress on joints impacted by Rheumatoid arthritis.¹⁰ Previous literature by Catherine et al., suggested static hand splint is useful in improving hand strength but hinders the ability to perform some fine motor tasks.¹² Another study by Bielefeld T support the present study as he suggested that the idea of orthosis is to support the wrist, corrects the ulnar deviation of the fingers, without restricting wrist and finger flexion/extension movements which might lead to enhancement of patient's quality of life and hand function.⁹

VI. CONCLUSION

With the experimental findings, we can conclude that the modified dynamic wrist hand orthosis is effective in improvement of grip strength and hand function in the subjects with ulnar deviated hand due to rheumatoid arthritis. Thus, the results support the experimental hypothesis of the study.

VII. CLINICAL IMPLICATION

The findings of the study suggest that modified dynamic wrist hand orthosis could be effective in improving grip strength and hand function among subjects with rheumatoid arthritis having ulnar deviation. The study indicated that application of dynamic orthosis could improve hand functions and grip strength without restricting activities of daily living among patients with Rheumatoid arthritis.

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