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Effectiviness of Volar Static Hand-Wrist Orthesis in Stroke Patients

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Abstract Objective: To evaluate the volar static hand-wrist orthoses, upper extremity motor development, manual dexterity and independence in daily life activities in stroke patients. Methods: Forty patients were prospectively randomized to use a volar splint or no splint (control group). All patients were included in a 6-week rehabilitation programme. Fugl-Meyer Assessment was used for clinical motor assessment, the Modified Ashworth Scale was employed for spasticity, the Nine Hole Peg Test (NHPT) was used for evaluating fine motor dexterity, and the Barthel index was employed for functional evaluation Results: Only a significant difference was found in the Modified Ashworth finger flexor values in Group 1 patients between hospitalisation and week 3 and week 6 but other scales were not significantly different among the groups. Conclusions: Volar static hand-wrist orthoses were shown to be particularly effective on finger flexors with exercise therapy in reducing muscle tone, and also beneficial exercise programmes in post-stroke rehabilitation.

Keywords: *Orthosis; Spasticity; Stroke*

1. Introduction

Stroke is defined as the non-traumatic brain injury characterized by neurologic deficits like loss of motor control, sensory alterations, cognitive and speech disorders or coma.[1] Upper extremity involvement and spasticity are observed commonly after stroke. Sufficient hand and upper extremity functions are required to perform daily living activities like feeding, hygiene and dressing independently. Studies have indicated that functional independence level gained through rehabilitation program of stroke patients is strongly associated with motor insufficiency of upper extremity and hand.[2] Wrist flexion spasticity and contractures may rapidly develop in patients who cannot receive early treatment after stroke.[3] Spasticity prevalence is reported as 38% after stroke.[4] Spasticity in stroke can be treated with medical treatment, stretching exercises, nerve blocks, trans-cranial magneto-therapy, splinting and surgical treatment.[5,6,7] Proper orthesis is performed considering the main functions like reaching, griping, carrying, releasing. It is aimed to prevent pain and edema, keep the hand in functional position, prevent contractures, loose up the contractures, prevent subluxation, support the arm for functional activities, accelerate to turn back to social and occupational life.[8,9] Ortheses should be systematically controlled with regard to adjustment and purpose, static ortheses should be used intermittently, compressed fields on bone protrusions should be avoided, tight ortheses may impair blood circulation, exercise program should be applied together with the orthesis.[1]

In this study, we aimed to evaluate the effectiveness of rehabilitation and volar static hand-wrist orthesis, upper extremity motor development, hand skills and independence in daily living activities using the scales of which validity and reliability were proven.

2. Materials and Methods

Forty patients who developed hemiplegia due to stroke and hospitalized for rehabilitation were included in the study. Diagnosis of stroke was verified through computed tomography (CT) and/or magnetic resonance imaging (MRI) techniques. Patients were randomly allocated to two groups. While Group 1 was composed of the patients who were applied volar hand-wrist orthesis, Group 2 was composed of the patients who were not applied orthesis. Patients in Group 1 used their ortheses for 6 weeks. Both groups received both conservative and neuro-physiologic exercises once daily at 5 days of the week during 6 weeks. Fugl-Meyer motor scale was used for motor assessment, upper extremity modified Ashworth scale was used for spasticity, nine hole peg test (NHPT) was used for hand skills, Barthel index was used for functional assessment. Sensory examination of the patients were also recorded. All patients were applied 6 weeks of rehabilitation program. Assessments were done on admission, at 3th week and 6th week and recorded.

Patients in Group 1 were given volar hand-wrist othesis (Figure 1).

Figure 1. Volar hand-wrist orthesis

The orthesis kept the wrist at 20 °extension, wrapped the hand-wrist from the volar side, kept the fingers in semi-flexion, thumb in abduction and opposition. The patients used the ortheses for 12 hours daily, mostly during daytime.

Statistical analysis

Statistical analyses were done using SPSS 22.0 program. A p level of <0.05 was accepted as statistically significant. The difference between groups with regard to demographic, clinical and etiologic characteristics was evaluated with chi-square test. Friedman test, Wilcoxon t-test and Mann-Whitney U test were used for clinical assessment. Frequency and percent values were calculated for concurrent pathologies, risk factors and complications.

3. Results

Both groups were similar with regard to mean age and duration of stroke. While mean age was 61.30±11.81 years (37 - 80) and duration of stroke was 8.25±2.36 (6 - 12) months in Group 1; these values were 62.95±11.25 years and 8.85±1.76 (6 - 12) months, respectively for Group 2 (Table 1).

A statistically significant difference was not detected between groups with regard to age (p=0.758) and duration of stroke (p=0.301). A significant difference was not detected between groups with regard to age, affected side, gender, marital status, education status, job, etiology and sensory examinations (p>0.05). A significant difference was not detected between modified Ashworth wrist flexor values on admission and 3th week, between the values and admission and 6th week in Group 1 (p=0.135, p>0.05). In Group 1, a significant difference was detected between modified Ashworth finger flexor values on admission and 3th week (p=0.02, p<0.05), between admission and 6th week (p=0.021, p<0.05) however there was not a significant difference between the values at 3th week and 6th week (p=0.564, p>0.05). In Group 2, a significant difference

was not detected between modified Ashworth wrist flexor values an admission and 3th week, between the values on admission and 6th week (p=0.607, p>0.05) and modified Ashworth finger flexor values (p=0.584, p>0.05)(Table 2).

Table 1. Mean age and duration of stroke of the groups

	Group 1 Mean ±SD (Min-Max)	Group 2 Mean ±SD (Min-Max)	P value
Age	61.30 ±11.81 (37 - 80)	62.95 ±11.25 (47 - 83)	0, 758
Duration of stroke	8.25 ±2.36 (6 - 12)	8.85 ±1.76 (6 -12)	0, 301

Table 2. Mean values of clinical assessments in Group 1 and Group 2

		Group 1 Mean ±SD		Group 2 Mean ±SD	
Modified Ashworth wrist flexors	On admission	0.80 ±0.83	p>0.05	0.40 ±0.60	p>0.05
	3th week	0.60 ±0.82		0.35 ±0.59	
	6th week	0.60 ±0.68		0.40 ±0.60	
Modified Ashworth Finger flexors	Yatış	1.05 ±0.83	p<0.01	0.60 ±0.88	p>0.05
	3th week	0.70 ±0.73		0.50 ±0.76	
	6th week	0.65 ±0.75		0.50 ±0.69	

A significant difference was detected between Fugl-Meyer values on admission and 3th week, between the values on admission and 6th week in both groups (p<0.001). A significant difference was not detected between hand skills on admission and 3th week, 6th week in both groups (p>0.05) (Figure 2).

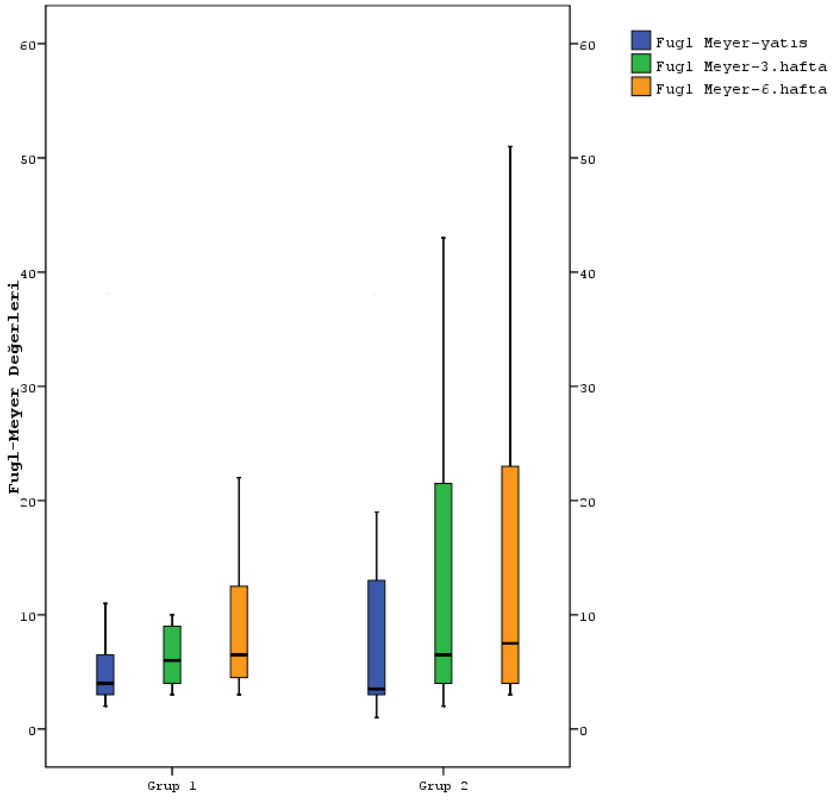

Figure 2. Fugl-Meyer values according to groups

A significant difference was detected between the values on admission and 3th week, on admission and 6th week (p=0.000, p<0.001), between the values at 3th week and 6th week in Group 1 and Group 2 (p=0.001, p<0.01). A significant difference was not detected between hand skill values on admission and 3th week, 6th week in Group 1 (p=0.368, p>0.05). A significant difference was not detected between hand skill values on admission and 3th week, 6th week in Group 2 (p=0.156, p>0.05). A significant difference was not found between groups with regard to modified Ashworth wrist flexor values and modified Ashworth finger flexors, Fugl-Meyer, hand skill and Barthel index values on admission, at 3th week and 6th week (Table 3).

Table 3. Comparison of clinical outcomes between Group 1 and Group 2

	Admission	**3th Week**	**6th Week**
Modified Ashworth wrist flexors	p=0.142	p=0.398	p=0.398
Modified Ashworth finger flexors	p=0.086	p=0.369	p=0.529
Fugl- Meyer	p=0.925	p=0.659	p=0.602
Hand skills	p=0.999	p=0.779	p=0.779
Barthel index	p=0.758	p=0.478	p=0.383

4. Discussion

Results of our study indicate that volar static hand-wrist orthesis is effective on reducing muscle tone, particularly on finger flexors together with exercise therapy. Conflicting results are available in literature about the effectiveness of orthesis. This may result from the differences between duration of use, patient number and duration of stroke. In the study of Pizzi et al. investigating the effect of orthesis on spasticity, 36 patients were analyzed with modified Ashworth scale (MAS). Patients were applied volar static orthesis for 3 hours daily during 3 months. A statistically significant difference was detected between MAS values before and after treatment. Elbow and wrist ROM values were detected to improve after orthesis use for 3 hours daily. Wrist flexor spasticity was detected to improve. Significant results may result from long duration of the study.[10] Lannin et al.[11] have investigated 63 stroke patients who were unable to do active wrist extension. Two types of volar orthesis as neutral and extension were used, a control group was composed of the patients who did not use orthesis. All three groups were applied exercise program for 6 weeks and a comparison was made between 3 groups. Motor development was evaluated with Motor Assessment Scale and spasticity was evaluated with Tardieu scale. Ortheses were used for 9-12 hours during 4 weeks and orthesis use was reported not to lead to an increase in movements and spasticity. The authors reported that wrist contracture is not reduced through both orthesis positions and routine orthesis use is not required following stroke. They have reviewed the literature and concluded that sufficient studies are not available to support the influences of hand-wrist orhesis use after stroke or vice versa. Basaran et al.[12] have compared dorsal orthesis, volar orthesis and control groups in a total of 39 patients and have found no difference between groups In another study of Lannin et al.[13] with similar duration, orthesis use for 12 hours every night during 4 weeks was shown not be effective on the contracture in wrist and finger flexors. In our study, a significant reduction was detected in finger flexor muscle tone. So we may conclude that volar static hand-wrist orthesis is effective on muscle tone, particularly on finger flexors. The studies in literature indicate that orthesis use has different effect on spasticity vary with duration of daily use. [10,11,12,13] Gamnhirin et al. [14] have reported that orthesis use is not effective for prevention of contractures and not different from the other methods. In our study, we evaluated hand skills with NHPT and did not find a significant difference between two groups with regard to hand skill values on admission, at 3th week and 6th week. This may result from the duration after stroke, our selecting the patients who do not have active extension particularly in the hemiplegic hand, not applying special treatment approaches in addition to standard rehabilitation programs. Sommerfeld et al.[15] have evaluated spasticity with MAS, hand skills with NHPT, Borthel index and some other tests for investigating the relationship between spasticity and disability (motor disorders and activity restrictions). The authors have detected a statistically significantly better motor and activity scores in non-spastic patients (n:77) compared to spastic patients (n:18). However the correlation

between muscle tone and disability scores was found low and disability severity was found similar between groups. According to the results, only 19% patients had spasticity 3 months after stroke although spasticity seems to lead to disability after stroke. These results indicate that focusing on spasticity is not significant as seemed in stroke rehabilitation. Causes of disability should be evaluated meticulously and continuously before making a decision for rehabilitation options. In our study, a significant difference was found between Fugl-Meyer values and Barthel index values on admission, at 3th week, 6th week; between admission and 3th week. These results indicate that exercise programs are beneficial besides orthesis. Porter et al. have investigated Fugl-Meyer (FM), Motor Assessment Scale, NHPT and Modified Ashworth Scale alterations. Patients maintained exercise program after the first assessment and were re-evaluated 3 months later. FM, NHPT and Modified Ashworth alterations were detected although little.[16] Upper extremity mobility and hand grip capacity were observed to increase in another study which used Fugl-Meyer, Motor Assessment Scale and Seaboflex splint which make measurements with goniometry.[17] Stroke patients show different healing patterns according to the results of our study and review of the literature. Our study has reveled that orthesis and exercise seem to be effective on reducing spasticity.

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5. Conclusions

Volar static hand-wrist orthesis was shown to be effective for reducing muscle tone together with exercise, particularly on finger flexors and, orthesis and exercise programs were shown to be beneficial together in rehabilitation after stroke.

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