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Splint satisfaction in the treatment of traumatic radial nerve injuries

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Abstract

Between the years 1986-2001, 135 patients who have had traumatic radial nerve injury, were supplied with dynamic wrist-hand orthoses (WHOs). The aim of this study is to examine the applied splints, considering aspects such as apperance, practicality of use, function, comfort and endurance.

The author's assessments show that the biggest problem was due to the unaesthetic appearance of the finger extensor spring of the splints. For this reason, modification of these finger extensor outriggers has been attempted. Also, aspects of the splints such as the problems faced and regeneration of the nerve, have been considered and modifications made in order to eliminate any disfunction.

This study reflects the reactions and satisfaction of 83 patients concerning the splints they have used. Conventional wire springs have been used in the splints of 71 patients, and 12 had modifications done on their outriggers. In terms of appearance, there were significant differences between modified outriggers and conventional outrigger ($p<0.05$). Also, when the modified outriggers were compared in terms of appearance and durability, there was a statistically significant opinion in favour of them ($p<0.01$).

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Introduction

The radial nerve is the most frequently injured in peripheral nerve lesions (Calandruccio and Jobe, 1992; Kline and Hudson, 1990; Kline, 1996).

All the dynamic splints used in radial nerve palsy are to prevent overstreching of the denervated muscles, preserve joint movements and prevent contractures, and establish normal functional use of hand during the period of recovery (Skirven, 1992; Colditz, 1987 and 1990).

The core of these splints is the cock-up splint used widely in the 1950s. This and similar splints hold the wrist in 30° extension and this wrist position enhances the grasp strength of the hand (Loth and Eversmann, 1997; Colditz 1987; Wilton and Dival, 1997; Fess and Phillips, 1987; Boscheinen-Morrin *et al.*, 1999).

During the years that followed, the spring wires in the structure of the Oppenheimer's and Thomas' splints, have permitted the passive extension of the wrist or the MCP joints. Some authors have stated the positive effects of doing passive extension exercises with dynamic outriggers and the mechanical effects produced during movements (Thompson and Littler, 1977; Wynn Parry, 1978; Carus *et al.*, 1993; Berger, 1996; Duncan, 1989). For this reason in the dynamic splints used for radial palsy until 1970s, it has been seen that extension has been produced with elastic bands at the wrist and with wire springs at the fingers.

In the last decade, the Granger splint identified by Crochetiere *et al.* (1975) and in 1987 Colditz's modification permitted the passive extension and active flexion of the wrist

and fingers, without the need of elastic bands or wire springs (Colditz, 1987 and 1990; Wilton and Dival, 1997; Crochetiere *et al.*, 1975).

In this study, the dynamic wrist hand orthosis (WHO), which is widely used in radial nerve injuries in the country were used, and the patients' level of satisfaction with them was considered. When the fingers relax in the splints, the wrist's elastic bands maintain wrist extension and stimulate finger flexion instead of fingers outriggers with springs. In the splint, the wrist is held in extension by dorsal elastic bands. Elastic bands are the most effective substitute for loss of the extensor muscles and protection from stiffness of the wrist. A lumbrical bar is added to the splint where hyperextension occurs in MCP joints. Thus the splint provides passive extension to the MCP joints and the wrist. In a case where active extension begins at the wrist due to radial nerve regeneration, the wrist piece is removed from the wrist-hand othosis (WHO) and a hand orthosis (HO) is used. Also, there have been modifications done to the outriggers of some splints in order to make them more aesthetic.

Patients and methods

From the 135 patients who suffered a traumatic radial nerve injury, 105 (78%) were female and 30 (22%) were male. The youngest patient was 3, the oldest was 47, and their average age was 25. Some 52 (39%) of the patients were injured on the right side, while 83 (61%) were injured on the left. The injury level of 85 (63%) of the patients was the upper arm, 34 (25%) at the elbow and 16 (12%) at the forearm level. According to the cases studied, the causes of radial nerve injuries can be classified as follows: 45 (33%) of them were related to a fracture due to a fall, 29 (21%) to an earthquake, 20 (15%) to a shooting, 17 (13%) to a traffic accident, 15 (11%) accident related to agriculture machinary, 9 (7%) to vocational accident. The injury mechanism was mostly (63%) fracture, contusion and laceration.

In 105 (78%) out of 135 patients, the radial nerve was injured alone, in 30 (22%) cases the radial nerve was injured along with extensor tendon injury. The first applications were dynamic WHO for 75 (56%) patients, elastic bandage for 30 (22%) patients, plaster of Paris for 15 (11%) and dynamic WHO and physiotherapy for 15 (11%). In 120 cases (89%) consultation to a doctor was within a day, but this period ranged from 1 hour to 18 years after the accident.

The period between the accident and splint use was 10 days (min) to 18 years (max). Aluminium dynamic WHOs have been applied to 35 patients. In 97 (72%) patients a lumbrical bar was added to the dynamic WHO and in 38 (28%) of patients' the dynamic WHO was without a lumbrical bar (Fig. 1). In the dynamic WHO, with lumbrical bar added a static lumbrical bar has been used on 83 (86%), and a dynamic lumbrical bar (Fig. 2) on 14 (14%). A dynamic lumbrical bar has been mostly prefered on patients where serious flexion limitation is seen in the MCP joints. In 16 (17%) patients with a lumbrical bar added to the dynamic WHO a high temperature thermoplastic sleeve has been added to control the weak stabilization caused by a broken forearm. In all of the 135 dynamic WHOs with finger MCP extensor springs, wrist extension have been achieved using elastic bands. In 27 of the patients with dynamic WHO a lumbrical bar was applied, after an average of 2.5 months. A HO was used instead of a WHO with the start of wrist extension due to nerve regeneration.

The thumb did not always have an outrigger

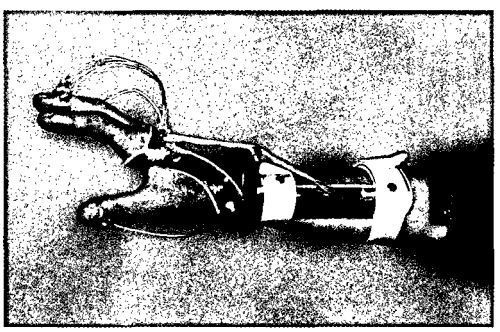


Fig. 1. WHO orthosis without lumbrical bar.

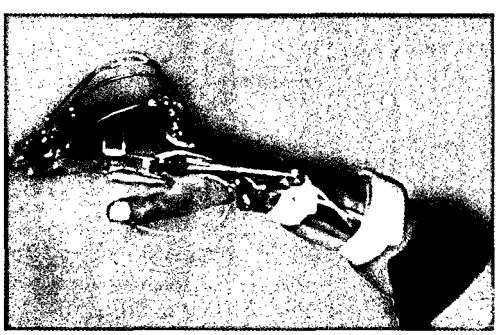


Fig. 2. WHO with dynamic lumbrical bar.

applied. When contracture of the thumb extensors and abductors was observed an outrigger was added to the thumb of 13 (10%) patients' dynamic WHO.

The splints were effectively used with the aim of functionality during the day, and support in the night. They were removed 3 times, for one hour each time, in a day. The use period of these splints is 1-24 months, while average use has been recognized as 4 months.

Flexion contractures of the wrist were not identified in the period of splint use. However there has been hyperextension deformity seen in MCP joints, after 3 months average, on 23 (61%) of 38 patients using the WHO without lumbrical bar. For this reason, a lumbrical bar had to be added to the splint. Thus the MCP joints were supported and the hyperextension deformities of MCP joints decreased because of the wire spring force the number of patients on whom the lumbrical bar has been applied was increased to 120.

Results of questionnaire

In this study a form was prepared to record the results of applying dynamic WHO to the wrist and MCP joints to enable passive extension and prevent flexion deformity. Aspects examined include the support and function provided, ease of putting on and taking off, endurance (durability of outriggers), satisfactory appearance (cosmetically pleasing), comfort, and whether these splints are useful in daily activities.

This written questionnaire was mailed or distributed to 120 patients, a total of 71 were returned. A review of results showed that the support and function provided focused on the wrist and fingers.

Most patients using splints with lumbrical bars 46 (65%) have found the splints to be "excellent" in terms of support and function. Also, a large group 39 (55%) have pointed out that they experienced no difficulty in putting on and taking off the splints. While 66 (93%) of the patients have not encountered any situation that would need repair because of bending or breakage of the splint, others 5 (7%) have mentioned that repair was necessary due to breakage of extensor springs. Most patients 45 (63%) found the splints comfortable. On the topic of the use of the splints in daily living activities (ADL), patients found it to be "good" 35 (49%) and excellent 28 (39%) while a small percentage 8 (11%) pointed out that they had problems holding cylindrical objects. None of the patients considered the splints' appearance good or excellent while 32 (45%) considered its appearance fair and 39 (55%) considered it poor. Most patients 41 (58%) found the price cheap (Table 1).

Some 66 of the dynamic WHOs used on 71 patients were with lumbrical bar, and 5 were without lumbrical bar. When the satisfaction of the patients of these two groups are compared, it is evident that 61 (92%) of the patients using WHOs with conventional extensor wire spring and bar, and 5 (100%) of the patients using the barless splints consider the durability to be "excellent". Four (4) (80%) of the patients who

Table 1. Satisfaction of patients from dynamic wrist hand orthosis (WHO).

Satisfaction	WHO (n=71)							
	Poor		Fair		Good		Excellent	
	n	%	n	%	n	%	n	%
Support and mechanical function	0	0.00	2	2.82	23	32.39	46	64.79
Ease on/off	0	0.00	0	0.00	32	45.07	39	54.93
Durability	5	7.04	0	0.00	0	0.00	66	92.96
Comfort	0	0.00	5	7.04	21	29.58	45	63.38
Ability of ADL	0	0.00	8	11.27	35	49.30	28	39.44
Appearance	39	54.93	32	45.07	0	0.00	0	0.00
Price	0	0.00	0	0.00	30	42.25	41	57.75

Table 2. Comparation of satisfaction of patients from the WHO with and without lumbrical bar with conventional wire spring.

Satisfaction	WHO with lumbrical bar and conventional wire spring (n=66)								WHO without lumbrical bar and with conventional wire spring (n=5)								p
	Poor		Fair		Good		Excellent		Poor		Fair		Good		Excellent		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Support and mechanical function	0	0.00	2	3.33	21	31.82	43	65.15	0	0.00	0	0.00	2	40.00	3	60.00	0.86
Ease on/off	0	0.00	0	0.00	30	45.45	36	54.55	0	0.00	0	0.00	2	40.00	3	60.00	0.81
Durability	5	7.58	0	0.00	0	0.00	61	92.42	0	0.00	0	0.00	0	0.00	5	100.00	0.53
Comfort	0	0.00	5	7.58	19	28.79	42	63.64	0	0.00	0	0.00	2	40.00	3	60.00	0.98
Ability of ADL	0	0.00	7	10.61	33	50.00	26	39.39	0	0.00	1	20.00	2	40.00	2	40.00	0.83
Appearance	38	57.58	28	42.42	0	0.00	0	0.00	0	0.00	4	80.00	0	0.00	0	0.00	0.11
Price	0	0.00	0	0.00	29	43.94	37	56.06	0	0.00	0	0.00	1	20.00	4	80.00	0.30

Mann Whitney's U test was used for the comparation of two groups.

used barless splints, stated that the appearance bothered them and termed their satisfaction as "fair". However, 38 (58%) patients using the WHO with lumbrical bar stated that they found their splints far from aesthetic and "poor" (Table 2).

All the patients stated that it was the extensor wire springs that lacked aesthetic appearance. This led us to modify the extensor outriggers on 15 patients. Twelve (12) patients with WHOs and 3 patients with HOs.

Modifications

This system is used to lessen the appearance of the extensor springs which take up a lot of space on the dorsal face, springs have been wrapped round the fingers and attached to the finger loops. This system was used on 5 of the patients (100%) who had WHOs without bars (Fig. 3).

In another modification, a combination of a fishing rod and elastic bands is used instead of springs. In this system a large transvere pulley was inserted on the lumbrical bar. First the fishing rods are tied to the finger loops, then the rods are stretched over the pulley and attached to the elastic bands (Fig. 4).

The 5 (100%) patients with modified WHOs with springs wrapped round the fingers (Figs. 3 and 5) were satisfied by its appearance. In terms of appearance, there is a statistical difference between the conventional wire spring and modified wire spring, in preference of the latter ($p<0.05$). Also, patients pointed out that the comfort and use of the modified extensor springs of the splints is not any different from that of

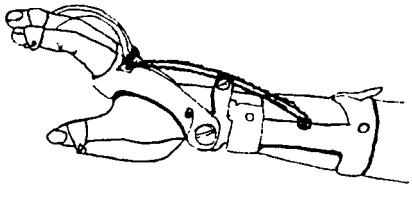


Fig. 3. WHO with modified wire spring wrapped round the finger wrapper.

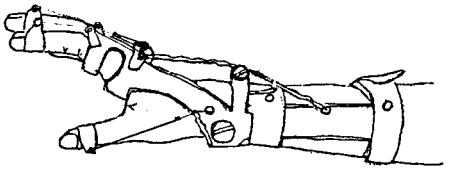


Fig. 4. WHO with combination of spring fishing rod and elastic band.

Table 3. Comparation of satisfaction of patients from the WHO without lumbrical bar with conventional wire spring and modified wire spring.

Satisfaction	WHO without lumbrical bar with conventional wire spring (n=5)								WHO without lumbrical bar with modified wire spring (n=5)								p
	Poor		Fair		Good		Excellent		Poor		Fair		Good		Excellent		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Support and mechanical function	0	0.00	0	0.00	2	40.00	3	60.00	0	0.00	0	0.00	0	0.00	5	100.00	0.16
Ease on/off	0	0.00	0	0.00	2	40.00	3	60.00	0	0.00	0	0.00	1	20.00	4	80.00	0.32
Durability	0	0.00	0	0.00	0	0.00	5	100.00	0	0.00	0	0.00	0	0.00	5	100.00	1.00
Comfort	0	0.00	0	0.00	2	40.00	3	60.00	0	0.00	0	0.00	2	40.00	3	60.00	1.00
Ability of ADL	0	0.00	1	20.00	2	40.00	2	40.00	0	0.00	0	0.00	2	40.00	2	40.00	1.00
Appearance	1	20.00	4	80.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	5	100.00	0.03*
Price	0	0.00	0	0.00	1	20.00	4	80.00	0	0.00	0	0.00	1	20.00	4	80.00	1.00

Wilcoxon test was used for the comparation of two groups.
* p value of less than 0.05 was considered statistically significant.

conventional splints. Although there is no statistical difference between the splint in use and comfort ($p>0.05$) patients using the modified spring WHO felt that their hands were better supported and found it easier to put on and take off (Table 3).

A combination of fishing rod and elastic band (Fig. 4) was used on 7 patients who were not satisfied with the appearance of their WHO with conventional extensor wire spring and lumbrical bar and their satisfaction was considered. Six (6) (86%) of the patients who tried the combination of fishing rod and elastic band splints found it "good". However, in terms of durability, 4 (57%) considered it "good" and 3 (43%) "fair" due to problems with the elastic bands (Table 4). The same patients had found the splints with conventional wire springs "excellent". In these 2 studies, the splints with combination of fishing rod and elastic band were found statistically significantly better in terms of appearance ($p<0,05$), and with conventional extensor wire spring better in terms of durability ($p<0.05$).

In the category of modified outriggers, patients prefered modified wire springs, to the combination of fishing rod and elastic bands, both in terms of appearance and durability. This result was found statistically significant ($p<0.01$).

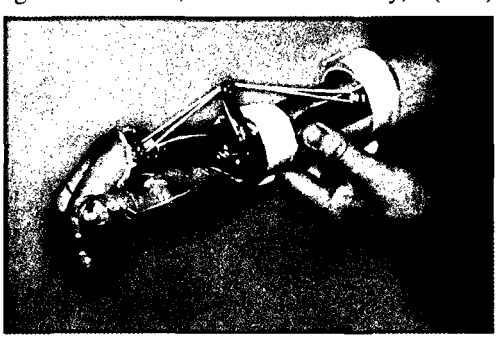


Fig. 5. WHO with modified spring

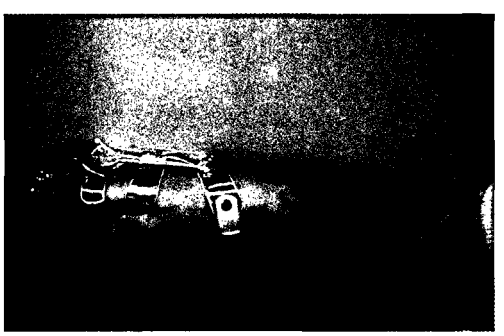


Fig. 6. Hand orthosis (HO) with combination of fishing rod and elastic band.

Table 4. Comparation of satisfaction of patients from the WHO with lumbrical bar with conventional wire spring/ combination of fishing rod and elastic band.

Satisfaction	WHO without lumbrical bar with conventional wire spring (n=7)								WHO with lumbrical bar and combination of fishing rod and elastic band (n=7)								p
	Poor		Fair		Good		Excellent		Poor		Fair		Good		Excellent		
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Support and mechanical function	0	0.00	0	0.00	1	14.29	6	85.71	0	0.00	0	0.00	0	0.00	7	100.00	0.31
Ease on/off	0	0.00	0	0.00	1	14.29	6	85.71	0	0.00	0	0.00	0	0.00	7	100.00	0.31
Durability	0	0.00	0	0.00	0	0.00	7	100.00	0	0.00	3	42.86	4	57.14	0	0.00	0.015*
Comfort	0	0.00	0	0.00	2	28.57	5	71.43	0	0.00	0	0.00	0	0.00	7	100.00	0.16
Ability of ADL	0	0.00	0	0.00	2	28.57	5	71.43	0	0.00	0	0.00	2	28.57	5	71.43	1.00
Appearance	5	71.43	2	28.57	0	0.00	0	0.00	0	0.00	1	14.29	6	85.71	0	0.00	0.015*
Price	0	0.00	0	0.00	2	28.57	5	71.43	0	0.00	0	0.00	2	28.57	5	71.43	1.00

Wilcoxon test was used for the comparation of two groups.
* p value of less than 0.05 was considered statistically significant.

HOs with lumbrical bars and combinations of fishing rod-elastic bands have been fitted to 3 patients who have active wrist extension motion (Fig. 6). They were using dynamic WHO with conventional extensor wire springs and bars before recovery of active wrist extension. However, the satisfaction results have not been included in this paper because the number of patients who had HOs were low.

Conclusion

Patients who have applied to the author's Prosthetics and Orthotics Department have motivated the Department to manufacture dynamic wrist-hand orthoses which are cheaper, but to which mechanical principles are applied.

However, the extensor outriggers present an asthetic problem for patients. For this reason, splints that take up less space, springs which go between the fingers and outriggers which make use of an elastic band-fishing rod combination provide an alternative. These modifications can be easily carried out by any competent orthotist. The only disadvantage of the splints made of aluminium is that it takes a long time to manufacture in the Department of Prosthetics and Orthotics. The department suceeded in minimising the time spent in the Prosthetics and Orthotics Department by the use of models prepared by the technician in the process of manufacture.

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