

A Comparative Case Study of Palmar Static and Dorsal Block Dynamic Digit Extension Splinting with Post Operative Dupuytren's Contracture Release

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Abstract

Objective: This study compares the effectiveness of palmar static digit extension splinting with dorsal block dynamic digit extension splinting on preventing postoperative secondary joint flexion contracture of metacarpophalangeal joints and proximal interphalangeal joints.

Method: Six patients with Dupuytren's Disease were randomly selected for this study and divided equally into two groups. Group A was fitted with the palmar splint and Group B with the dorsal splint. Both groups were fitted with the experimental splints at the end of their first initial evaluation session. All patients received six months of comprehensive hand therapy. Patients were also assigned a program of independent daily home exercise. Objective measurements of at the initial evaluation and during the 12th and 24th week of hand therapy.

Results: This study found significantly greater improvement of ROM from using the dorsal block dynamic digit extension splint than with the palmar static digit extension splint when combined with comprehensive hand therapy.

Key Words : Dupuytren's disease, Prevention of flexion contracture of MP, PIP joints, Palmar static digit extension splinting, Dorsal block dynamic digit extension splinting, Open palm total fasciectomy, Comprehensive hand therapy

INTRODUCTION

Dupuytren's contracture is a result of thickening

of the palmar fascia or aponeurosis. Dupuytren's disease, first explained by Guillaume Dupuytren in 1831, is a disorder of the palmar fascia in

which nodules and thick cords form with fibrosis causing flexion contracture of the metacarpophalangeal and proximal interphalangeal joints. There is no known etiology, but there is frequently a family history. According to several researchers, it has a positive genetic history of 25% or more (McGrouther, 1990). The condition is more likely found in patients with a chronic disease such as diabetes, epilepsy, or pulmonary tuberculosis, and in patients with a history of alcoholism. Dupuytren's contracture presents a significant challenge to the therapist.

Dupuytren's contracture progresses over many years at an unpredictable rate. McFarlane (1984) reports that the contracture generally will be more severe with any of the following factors: early onset, family history, bilateral hand involvement, or involvement of the fascia in the feet or penis. The palmar fascia lies between the skin and the flexor tendons, extending from the palmaris longus tendon to the middle phalanges. The palmar fascia connects on the medial side to the fascia of the hypothenar musculature; on the lateral side, the palmar fascia connects with the fascia of the thenar eminence. The aponeurosis connects to the interosseous fascia by fibrous bands between the flexor tendons, neurovascular bundles and lumbricals. The first indication of disease is a proliferation of fibroblasts, resulting in dimpling of the skin or nodule formation. This most commonly occurs at the distal palmar crease proximal to the ring and small fingers, but may include any of the digits. The index and thumb are least commonly involved. The fascia is usually affected in the palm itself, but may be affected near the proximal phalanx. In the most

advanced state, the collagen fibers mature.

With this condition, there is progressive joint contracture. The nodule thickening eventually results in contracture of the MCP and/or PIP joint. There is collagen formation and myofibroblasts proliferate. Furthermore, circulation progressively decreases and there can be atrophy of the skin. McFarlane (1984) advocates surgical treatment once the contracture exceeds 30 degrees, and the nodules become painful or skin integrity is threatened. Unfortunately, many patients wait until the contracture is significantly greater than 30 degrees and interferes to an unacceptable extent in activities of daily living. Problems are usually noted first when attempting to insert the hand into a pocket, put on gloves or open the hand prior to gross grasp. If the contracture has progressed significantly, the rehabilitation course will be more difficult due to the shortening of secondary tissues.

Previous researchers have acknowledged that flexion contracture of metacarpophalangeal joints, especially proximal interphalangeal joints, is a significant problem following surgery for Dupuytren's Disease. The present study attempted to compare two methods of postoperative splinting on the basis of preventing secondary joint flexion contracture. The two methods used were the palmar static digit extension splint and the dorsal block dynamic digit extension splint.

Total fasciectomy of the open-palm produces massive surgical wounds in the palm, which causes many problems. The major problems met with postoperative therapy intervention are edema, hematoma and constant pain in the hand.

These problems cause hesitation in doing assigned routine exercises. The fear of producing pain and bleeding during Active Range of Motion (AROM) and Passive Range of motion (PROM) exercises interferes with postoperative therapy. A common occurrence of postoperative failures are metacarpophalangeal joint or interphalangeal joint flexion contracture ($20 < 30$) (Iselin, 1990).

In order to achieve successful results, there is a need for the patient to have an informed understanding of surgical procedures and motivation to cooperate with therapeutic intervention focusing on hand rehabilitation. Successful surgery of Dupuytren's contracture release requires early, intensive, appropriate and

sustained postoperative care and treatment intervention. An appropriate splinting procedure along with a specific routine of AROM and PROM exercises will enhance full recovery of the surgical wound (Jain et al., 1988).

In the present study all subjects received the same therapeutic intervention, only the method of postoperative splinting was varied. This study compares the effectiveness of the palmar digit extension splint with the dorsal block dynamic digit extension splint in preventing postoperative secondary joint contracture of the metacarpophalangeal (MP) and proximal interphalangeal joints (PIP) (Jain et al., 1988; Mackiin and Bryant, 1990; McFarlane 1984; McGruther, 1990).



Figure 1.
Pre-operative Patient's hand.
90° flexion Contracture at the MP joints.



Figure 2.
Surgically removal of
Dupuytren's disease



Figure 3.
Post-op.3 days(lateral view of Patient's
Hand and the splint) Fabrication of Dorsal
Block Dynamic Digit extension splint



Figure 4.
Palmar View of Dorsal Block
dynamic digit extension splint
(Full extension of patient's digits)

METHOD

Participants

Six subjects retired U.S. veterans with a history of Dupuytren's disease were randomly selected from a pool of candidates. All of these subjects had symptoms of Dupuytren's disease for a period of two to five years. Their mean age was 69 years.

Indications for surgery:

1. Each patient had one or more thick nodules in the palm of his hand
2. Flexion contracture of 30 to 65 at proximal interphalangeal joints and metacarpophalangeal joints (Boscheinen-Morrin et al., 1985; Eckhouser, 1990)
3. Some difficulty with ADL functions and their productive functions
4. The mean follow up time since the onset of disease was 44.3 months (20 to 60 months)

The six subjects were seen by the V.A. surgical team and agreed to the surgery. Prior

to surgery each patient was seen by this therapist at the occupational therapy hand clinic and was informed of the purpose of this study. All patients received an open palm total fasciectomy from the surgical team at the Veterans Administration hospital on Long Island, New York. Surgeries took place between January 28th, 1994 and March 18th, 1995. Immediately following the surgery each patients' hand was immobilized with a half plaster splint (Jain et al., 1988). Later the thick surgical-dressing was carefully removed and replaced with a light dressing and Coban wrap and AROM was carefully measured (Lee, 1986).

Procedures

Group A patients were fitted with the palmar static digit extension splint (figure 6), while group B were fitted with the dorsal block dynamic splint (figure 5). Patients wore their splints during the day, removing them to do exercises and then replacing splints after exercise.



Figure 5. Dorsal Block Dynamic Digit Extension Splint



Figure 6. Palmar Static Digit Extension Splint

Patients were given specific instructions to mobilize each digit actively five times on the hour, every hour, during waking hours. The patients were also fitted with a night resting hand splint with Velcro straps to fasten proximal interphalangeal Joints and distal interphalangeal joints in full extension while sleeping at night.

The patients were scheduled for therapy five times per week for the first two weeks.

Thereafter, therapy was reduced to three times per week, beginning the third week following the surgery. The therapy program was as follows:

1. Edema reduction treatment by:
 - a. Instructions to elevate affected hand above head
 - b. Perform exercise
2. Wound care treatment
 - a. Whirlpool with nondependent position. During whirlpool treatment, Patient was to perform certain ROM exercises (digit extension/flexion; make into a fist/open hand) as best as they can.
3. Active, active assisted and gentle passive PROM exercises with care.
 - a. Initially, five to seven gentle repetitions were used with a gradual increase in repetitions according how each patient progressed.
4. Scar management:
 - a. gentle massage with vitamin E ointment, utilization of Elastomere under the splint for six to eight months or more if needed when wounds were healed.
5. Basic ADL activities were encouraged.
6. Gentle and light stretching exercises were

continued and resistive exercises were gradually introduced once wounds were closed.

7. Patient's splints were adjusted according to each patient's progress.
8. Close observation of patient's hand for any complication or development of deformity in hand or digits.

1) Splinting material

- (1) Orthoplast or Aquaplast-T (2.4mm) (13cm length, 5.5cm width)
- (2) Three finger loops with three rubberbands
- (3) Four self-adhesive velcro hooks(1cm×1cm)
- (4) Three self-adhesive velcro hooks(4cm×1.5cm) and piles(4cm×1.5cm), push a small hole to connect with one rubber band
- (5) Cut out a piece of molestick padding (slightly larger than already cut out splint)

Table 1. Rubberband's traction scale

CM	1 RUBBERBAND	2 RUBBERBANDS	
1	31.67	28.33	20
2	48.33	55.00	45
3	76.67	70.00	65
4	78.33	91.67	90
5	116.67	110.00	105
6	130.00	123.33	125
7	148.33	141.67	140
8	161.67	151.67	160
9	176.67	165.00	175
10	195.00	183.33	180

*Traction 7cm to 10cm must be suitable traction stress to postoperative digits. Patient was able to tolerate the stress on hand(Table 1).

2) Splint fabrication

(1) Palmar Static Digit extension Splint

The palmar static resting splint has been traditionally used by many therapists, postoperatively. The majority of the patients felt very comfortable wearing this type of splint after surgery. All digits were slightly flexed under the thick dressing with no specific stretching or stress. The surgical wound healed under this condition, which enhanced the contracture of scar tissue, and thus development of flexion contracture of the metacarpophalangeal joints and/or proximal interphalangeal joints. Keeping this in mind, immediate therapeutic intervention is needed to prevent and also correct the flexion contracture deformity.

After a complete evaluation of a subject's hand, fabrication of a palmar static digit extension splint is as follows:

- ① Draw a splint pattern by placing the patient's hand palm down on tracing paper
- ② Draw around the hand, except the thumb, if the thumb is not involved
- ③ Mark the first web space, between thumb and index finger
- ④ Cut out the pattern and place it on the palmar aspect of patient's hand, to determine if the pattern fits correctly.
- ⑤ If correct, trace the pattern on the thermoplastic material(Orthoplast, Aquaplast or any other suitable splinting materials).
- ⑥ Dip the thermoplastic sheet in hot water (110~120F) to soften it, and cut out the pattern with scissors.
- ⑦ Cut three self-adhesive Velcro hook strips

(2 length by 1 width) and three pieces of Velcro pile long enough to fasten splint to patient's hand

- ⑧ Cut out padding, slightly longer than patient's splint for the inner surface of splint for comfort
- ⑨ Reheat the previously cut thermoplastic splint in the hot water(110~120F) to re-soften the material and mold it onto patient's hand over dressing
- ⑩ Attach self-adhesive Velcro strips to the molded splint one each side of wrist to support the wrist, one to support the metacarpophalangeal joint, and one to support the proximal interphalangeal joints.

Make sure the splint fits the patient's hand caution with bony areas. All digits should be in fully extended. The patient should wear the splint continuously four hours, and then remove it for exercise, and replace it after exercise.

(2) Dorsal Block Dynamic Digit Extension Splint

After a complete evaluation of the subject's hand, fabrication of a dorsal block dynamic digit extension splint is as follows:

- ① Trace a splint pattern around the dorsal aspect of the subject's hand on tracing paper.
- ② Put several marks around all of the digits to the proximal interphalangeal joint of the affected digits(third, fourth or both) and continue to trace the subject's hand on the tracing paper.
- ③ Cut out the pattern and check it against the subject's hand for accuracy of the fit.
- ④ Trace the paper pattern onto thermoplastic

material(Orthoplast, Aquaplast or other suitable material, 2.4mm thick and 13 cm long × 5.5cm wide).

- ⑤ Dip the thermoplastic material into hot water(110~120F) to soften it before cutting out the pattern with scissors.
- ⑥ Cut three self-adhesive Velcro hook strips (2" long and 1" wide)
- ⑦ Cut three pieces of Velcro pile long enough to fasten the splint to the subject's hand.
- ⑧ Cut padding, slightly longer than the splint, for the inner surface of the splint for comfort.
- ⑨ Reheat the previously cut out thermoplastic splint by dipping it in hot water(110~120F), and carefully mold it over the dorsal surface of the subject's hand over light dressing and Coban wrap, making sure all digits are fully extended.
- ⑩ Attach the self-adhesive Velcro hook strips to each side(edge) of the splint at three levels: the wrist, mid-palm at the metacarpophalangeal joint, and at the proximal interphalangeal joint.
- ⑪ Cut three pieces of Velcro pile(2" long×1" wide) and form them into loops large enough to fit loosely over a finger. Cut a hole in each end of the Velcro strips and attach a rubber band(0.15×0.1×12cm; see Table 1 Rubber Band Traction Scale) through the holes of each strip, forming a loop or "outrigger." Attach another small piece of Velcro pile to the other end of the rubber bands. These will act as anchors for the outriggers.
- ⑫ Place the outrigger around the distal

interphalangeal joint of each digit and pull the digit gently with the rubber band toward the dorsal aspect of the splint. Attach the Velcro pile anchors to Velcro hooks on the dorsal aspect of the splint above the wrist to maintain a gentle pull on the affected digits with full extension (see Figures 5 and 6).

The patients should observe for digit circulation and edema in the hand.

RESULTS

Comparative measures of flexion and extension for all subjects are shown below in Table 2. Subjects in both groups improved ROM at 12 weeks post-surgery and continued improvement at the 24th week evaluation. However, group B subjects, who wore the dorsal block dynamic digit extension splint, showed far greater improvement than subjects who wore the palmar static digit extension splint. In particular, M.T., a group B subject, showed significant improvement in metacarpophalangeal joint extension of his small fingers (25 degrees and 49 degrees respectively). D.W., another group B subject, also showed significant improvement in proximal and distal interphalangeal joint flexion of his small fingers (37 degrees and 29 degrees respectively).

The present study clearly found that those subjects using the Dorsal Dynamic extension splint showed greater improvement in both flexion and extension in both the MP and PIP joints. Furthermore, the most severely contracted cases (MT and DW), both of whom wore the Dorsal Dynamic splint, had the largest

improvement during the study. The difference in the effectiveness of the splints can be illustrated by comparing the average change in movement measured at 12 and 24 weeks. Figure 8 graphically compares the average change in both groups.

In looking at the average change between the groups it is immediately apparent that the Dorsal dynamic splint outperformed the Palmar static splint in every measurement. Also, it is apparent from figure 8 that the improvement in

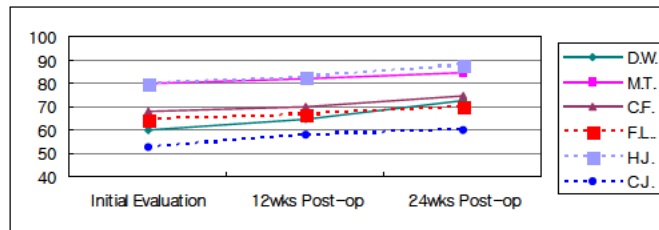
the latter half of the therapy was more dramatic with the Dorsal dynamic splint-- that is, the rate of improvement was noticeably greater for this type of splint. As Dupuytren's disease is typified by the inability to extend the small digits of the hand, the significantly greater improvement in extension resulting from the use of the Dorsal dynamic splint particularly impressive.

It could be argued that group differences may be exaggerated in this study because the

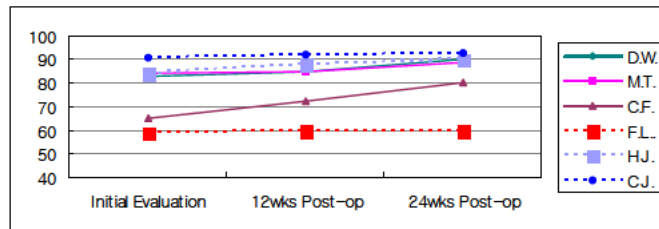
Table 2. Comparison of ROM among subjects in Group A and B

				Initial Evaluation		12wks Post op		24wks Post op	
				Flexion	Extension	Flexion	Extension	Flexion	Extension
Group A (Palmar static extension splint)	F.L.	4th digit	MP	65	15	67	15	70	13
			PIP	59	5	60	0	60	0
		4th digit	MP	65	8	67	8	70	5
			PIP	53	10	58	10	60	8
	H.J.	4th digit	MP	80	14	83	10	88	5
			PIP	84	5	88	3	90	3
		5th digit	MP	86	15	87	12	87	8
			PIP	87	0	88	0	88	0
	C.J.	4th digit	MP	53	7	58	5	60	5
			PIP	91	20	92	17	93	15
		5th digit	MP	74	0	55	0	58	0
			PIP	86	0	86	0	86	0
Group B (Dorsal block dynamic extension splint)	D.W.	4th digit	MP	60	16	65	10	73	2
			PIP	83	18	85	10	90	8
		5th digit	MP	47	10	65	5	84	3
			PIP	58	0	75	0	87	0
	M.T.	4th digit	MP	80	5	82	3	85	0
			PIP	84	41	85	25	89	16
		5th digit	MP	78	8	80	3	85	0
			PIP	77	61	77	25	79	12
	C.F.	4th digit	MP	68	5	70	0	75	0
			PIP	65	10	72	6	80	3
		5th digit	MP	70	5	73	0	78	0
			PIP	65	8	70	5	75	3

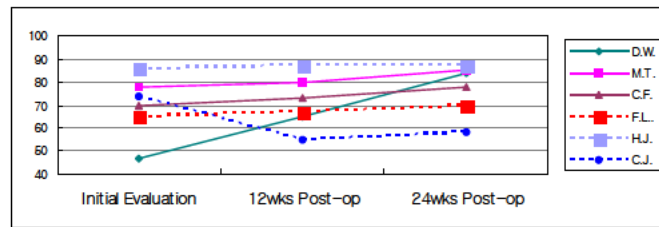
4th digit MP



4th digit PIP



5th digit MP



5th digit PIP

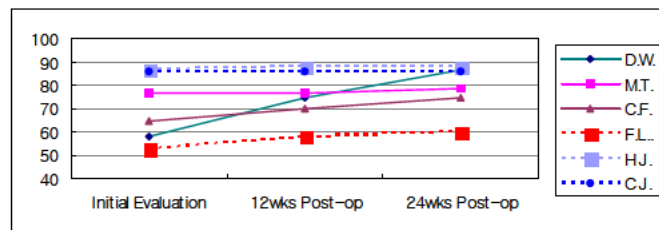


Figure 7. Comparison of ROM of each subjects in 4th digit MP/PIP and 5th digit MP/PIP

Group A-Palmar static extension splint~F.L., H.J., C.J.

Group B-Dorsal block dynamic extension splint~D.W., M.T., C.F.

subjects with the least initial extension were in Group B, thus the average change for group B was greater simply because there was greater ROM to be improved. It should be noted that patient M.T., although greatly improved, nevertheless had considerably limited extension after 24 wks of therapy. However, this interpretation can be rejected for several reasons. Firstly, patients with Dupuytren's disease who have severe contracture can be expected to show less post-operative improvement than those patients whose contracture is milder. Viewed from this perspective, M.T.'s post-operative improvement is even more remarkable. Secondly, if we eliminate M.T. from the analysis, the remaining two subjects in group B still show greater average change in all categories over group A. If the most extreme patient exaggerated the differences between groups, then we would expect to see that categories not affected by this patient would not show a pattern of difference between the groups. Instead, we find superior improvement in all categories for group B, whether M.T. is included in the analysis or not. Thirdly, if we compare individual cases that are similar at the initial stage in both groups (e.g. C.J. and D.W.), we find that those who used the Dorsal dynamic splint show greater improvement. Finally, the objection to extreme cases is nullified if the final restoration of ROM is the basis for comparison. Here, particularly in the case of extension of the MP joint, we find that those who used the Dorsal dynamic splint achieved greater ROM at the end of the therapy. Indeed, for subjects M.T. and C.F. MP extension was completely restored in both digits,

something which only occurred for those who used the Dorsal dynamic split. Thus, the general differences between the groups are due to the type of splint used, rather than the result of differences in the initial condition of individual subjects.

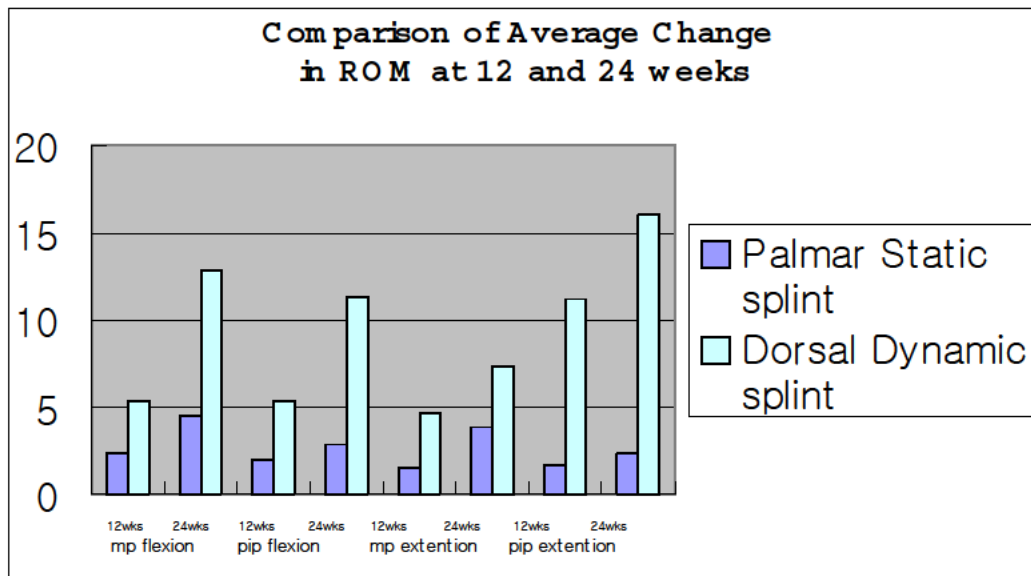
The data also indicate that significant improvement resulted from second 12 weeks of therapy, even more so in the case of the Dorsal dynamic splint. The clear implication is that long-term therapy is necessary for post-operative recover for these patients. Indeed, it is a very real possibility that even more improvement could be achieved by extending the therapy considerably beyond the 24 weeks used in this study. Much longer use of the splints with therapy is a topic for future research.

Of course, caution should be used in generalizing these results due to the small size of the study. The present study is a preliminary study and there is a need for future studies involving a larger number of subjects, and perhaps longer periods of time. Nevertheless, this study did control for factors other than the type of splint used and the strong differences found indicate that the type of splint employed can make a significant difference in the range of movement that the Dupuytren's patient can achieve.

DISCUSSION

Dupuytren's disease is a crippling disorder affecting the human hand. It causes difficulty with ADLs and productive activities. According to several researchers, it has a positive genetic history of 25% or more (McGrouther, 1990).

Table 3.



Dupuytren's disease, first explained by Guillaume Dupuytren in 1831, is a disorder of the palmar fascia in which nodules and thick cords form with fibrosis causing flexion contracture of the metacarpophalangeal and proximal inter-phalangeal joints. This author has been implementing both the traditional palmar static digit extension splint and the dorsal block dynamic extension splint with outrigger (finger) loops for postoperative treatment (Lee, 1986). The dorsal splint demonstrated a better outcome than the palmar splint. Of course, this is a preliminary study comparing these two types of splints and recovery depends also on specific comprehensive hand therapy along with splinting and patient participation.

Dupuytren's contracture release requires long term care and specific postoperative hand therapy. Even with successful surgery and therapy, many patients suffer a recurrence of Dupuytren's contracture (Hueston, 1990;

Rombouts et al., 1989; Welsh and Spencer, 1990). In this study, the group of subjects who received the dorsal block dynamic digit extension splint demonstrated significant postoperative improvement in AROM especially in digit extension and flexion.

However, this study is very preliminary and a longer term study of a larger sample with a longer period of postoperative care is recommended in order to generalize the results. Nevertheless, the results demonstrated by subjects wearing the dorsal block dynamic digit extension splint appear promising and warrant further study.

CONCLUSION

Massive surgical scars resulting from Dupuytren's release surgery need specific long-term care in terms of scar reduction and rehabilitation in order for patients to regain and

maintain hand mobility. Generally, people tend to resist moving painful body parts, which creates stiff joints and flexion contracture. Movement often creates bleeding from the surgical wound, which may lead to anxiety and depression. Therapists must apply appropriate splinting, AROM and PROM exercises, combined with simple functional tasks to improve and maintain joint motion and prevent flexion contracture. Furthermore, therapists need to understand their patients' physical and mental condition resulting from trauma in order to enhance their recovery from surgery and improve joint motion. Appropriate splinting is just one aspect of care, but if dorsal block dynamic digit extension splints can reduce flexion contracture and improve mobility, therapists should examine their usefulness within a comprehensive treatment program(Mackin and Byron, 1990).

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