Objectives. This study compared soft versus hard resting hand splints on pain and hand function in 39 persons with rheumatoid arthritis. Splint preference was also evaluated to determine its effects on splint wear compliance.

Method. A repeated measures research design was used to compare the two experimental conditions, wearing a soft splint versus a hard splint on the dominant hand for 28 days at night only, and an unsplinted control period of 28 days.

Results. Arthritis pain was considerably less during both splinted periods when compared with the pretest. Subjects identified fewer joints as being painful during the soft splint condition than during the unsplinted condition. There were no significant differences among conditions on hand function measures. Splint preference was 57% for the soft splint, 33% for the hard splint, and 10% for no splint. Splint wear compliance was significantly better with the soft splint (82%) than with the hard splint (67%).

Conclusion. The findings indicate that resting hand splints are effective for pain relief and that persons with rheumatoid arthritis are more likely to prefer and comply with soft splint use for this purpose. Individualized splint prescription that focuses on client comfort and preference may enhance splint wear compliance.

In the conservative management of rheumatoid arthritis, occupational therapists may provide resting hand splints to reduce inflammation, relieve pain, protect joints, provide support, reduce stiffness, and prevent deformity (Falconer, 1991; Philips, 1989). However, in clinical practice, many therapists and physicians have observed poor compliance with resting hand splint wear. Clients cite numerous reasons for not wearing the splints, including lack of comfort and poor wearing tolerance. The development of lightweight thermoplastic materials and soft splint options have enhanced comfort and may contribute to greater splint wear compliance.

Literature Review

Effects of Splint Wear on Arthritis

Immobilization through splinting has been found to have beneficial effects on the symptoms of arthritis. Splinting reduces the stress on the damaged joint capsule and the synovial lining, allowing immunological resources to concentrate on reducing inflammation. Muscles surrounding painful joints often develop spasms that produce deforming forces and more pain. Splinting breaks the pain-spasm-pain cycle by decreasing the pain typically associ
ated with motion and by providing support that allows the muscles to relax (Melvin, 1982).

Gault and Spyker (1969) reported a decrease in disease activity after 3 weeks of immobilization of the upper extremity with plaster splinting compared with the unsplinted limb. They also found that the immobilized extremity never showed signs of inflammation, even when moderate inflammation occurred in other joints. The authors recommended immobilization for control of symptoms related to acute inflammation. Partridge and Duthie (1963) also reported that complete immobilization of actively inflamed joints results in control of local symptoms and reduced disease activity. They recommended that a period of complete immobilization can be used safely to reduce pain, muscle spasm, and disease activity.

Several authors (Fess & Philips, 1987; Flatt, 1983; Philips, 1989) have advocated the use of resting hand splints during acute exacerbation of rheumatoid arthritis, which is characterized by swelling, joint inflammation, and pain. Ouellette (1991) recommended that splints be used to immobilize the wrist, metacarpophalangeal (MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints and that splinting be initiated early in the course of the disease. According to Ouellette, if inflamed joints are immobilized by a splint for several weeks after a flare, surrounding tissues could repair themselves in a more functional position, as they do after trauma. Shalit and Decker (1965) also noted that night splinting was particularly valuable to persons with rheumatoid arthritis because it inhibited flexor muscle spasm, which contributes to further pain and deformity. Because hand function in rheumatoid arthritis is initially impaired by pain and compromised further by the mechanical derangement of the joint caused by immobilization, splinting the hand to relieve symptoms and disrupt the process of inflammation may be helpful in maintaining function of the hand and upper extremity (Falconer, 1991).

**Splint Materials**

Although immobilization of arthritic joints with splints has a reported positive effect, there is no consensus regarding the best choice of splint materials. Hand splints for rheumatoid arthritis have been fabricated from plaster of paris (Flatt, 1983; Rotstein, 1965), aluminum (Nicole & Presswell, 1975), fiberglass (Rotstein, 1965), thermoplastics (Melvin, 1995; Philips, 1989; Spelbring, 1966; Van Brocklin, 1966; Zockeler & Nicholas, 1969), and silicone foam (Shalit & Decker, 1965). Use of air pressure splints (McKnight & Schomburg, 1982) and a variety of prefabricated splint options (Merritt, 1987) has also been reported.

Choice of splinting materials is influenced by client needs and conditions. Clients with rheumatoid arthritis may experience tenderness with pressure over joint surfaces, and their skin may be delicate from long-term corticosteroid use (Fess & Philips, 1987). Presence of joint deformities and joint swelling may prohibit use of unyielding rigid materials. Because client comfort and wearing tolerance influence compliance, the splint materials are important considerations in a treatment regimen. Improvements in thermoplastics combined with the introduction of soft splints provide more options for selecting materials that are easily molded, lightweight, and comfortable and may make splinting of painful, swollen, or deformed joints more acceptable to clients (Merritt, 1987).

**Compliance**

A variety of factors may influence compliance to a particular therapeutic regimen in the treatment of rheumatic disease, including features of the disease, the client, understanding of the regimen, client–practitioner interaction, and physician–family expectations (Hicks, 1985). Clients are generally more compliant with a therapeutic regimen when the benefits are immediately obvious, and pain relief has been consistently identified as a compliance-enhancing factor in the treatment of rheumatoid arthritis (Hicks, 1985). In their study of resting hand splint use by clients with rheumatoid arthritis, Feinberg and Brandt (1981) found that 62% of clients provided with bilateral resting hand splints wore them as prescribed and that compliance was greater during periods of inflammation when pain relief was a major consideration. In their critical review of compliance studies of persons with rheumatoid arthritis, Belcon, Haynes, and Tugwell (1984) found that compliance rates with splint usage ranged from 25% to 65%. They recommended that clinicians reevaluate their prescribing practices because failures of a particular intervention may actually reflect the client's noncompliance. They also encouraged clinicians to recognize the need to develop innovative strategies to improve compliance.

Other compliance-enhancing factors are family support (Oakes, Ward, Gray, Kaluber, & Moody, 1970), knowledge of the benefits of splinting (Nicholas, Gruen, Weiner, Crawshaw, & Taylor, 1982), and the therapist–client interaction, which is based on the therapist's use of an experimental model to apply learning principles, shared expectations, and positive affective tone and behaviors (Feinberg, 1992). Overall compliance in Feinberg's experi-
mental group was 82.5%, a higher percentage than any previously reported in the literature.

Poor cosmesis, discomfort, interference with function, and failure to relieve pain have been cited as factors that reduce splint wear compliance in persons with rheumatoid arthritis (Hicks, Leonard, Nelson, Fisher, & Esquenazi, 1989). However, the influence of client comfort and preferences for a particular splint material on splint wear compliance have not been studied. In addition, empirical data supporting the use of particular materials are lacking, leaving therapists to make selections on the basis of their own preferences or availability of materials. Therefore, this study was conducted both to compare the effects of soft versus hard resting splints on hand pain and function and to determine the effect of splint comfort and preference on compliance. We hypothesized that a soft-padded splint with a lightweight thermoplastic insert would be preferred over a hard thermoplastic splint and would yield better pain relief, hand function, and compliance. We speculated that the simple intervention of a preferred splint type would increase compliance and, consequently, any beneficial effects caused by splinting.

Method

Research Design

A repeated measures design was used with subjects serving as their own controls. Experimental treatment periods (28 nights each) included treatment with the soft splint, treatment with the hard splint, and unsplinted (control). The order of assignment to treatment periods was randomized.

Subjects

Subjects were recruited through a notice in an arthritis newsletter and by rheumatologist referral. Inclusion criteria were confirmed diagnosis of rheumatoid arthritis on the basis of the American Rheumatism Association 1987 revised criteria for classification (Arnett et al., 1988) and the presence of hand pain, morning stiffness, or both. Persons with a coexisting condition of fibromyalgia, carpal tunnel syndrome, or other neurologic or orthopedic condition were excluded from the study. After physician verification of diagnosis, potential subjects were screened by telephone inquiry. Forty-five subjects met the established criteria and volunteered for the study. Of these, five subjects did not complete the study because of medical or personal reasons, and one subject reported poor tolerance for splint wear, which restricted her movement at night during her first (soft splint) experimental period.

The remaining 39 subjects who completed the study were 36 women and 3 men. Ages ranged from 19 to 76 years, with a mean age of 51 years. Years since receiving the diagnosis of rheumatoid arthritis ranged from 1 to 53 years, with a mean of 14.5 years. Thirty-three (85%) subjects were right hand dominant. Previous resting splint use was reported by 21 (54%) subjects, with only 5 (13%) reporting splint use at the onset of the study.

Splints

Both the soft splint (see Figure 1) and the hard splint (see Figure 2) were wrist–hand extension immobilization splints, type 0 [16] (American Society of Hand Therapists [ASHT], 1992b). The soft splint was a cotton-padded wrap with a custom-fabricated 1/16-in. thermoplastic insert. The hard splint was made of 1/8-in. thermoplastic with strapping attached. All splints and inserts were fabricated by the same therapist. The wrist was positioned in neutral to slight dorsiflexion with MCP joints in 25° to 30° flexion, PIP joints in 30° flexion, and thumb in palmar abduction as recommended by Fess and Philips (1987), except in a small percentage of cases where contracture prevented this position. The resting position of each splint was standardized by goniometric measurement according to ASHT recommendations (ASHT, 1992a). Standard wear and care instructions were provided, which included instructing the subjects to return if swelling, redness, or pressure areas developed. None of the subjects returned for adjustment. Only the dominant hand was splinted to more accurately evaluate effects on hand function.

Measurement

Five measurements were used in this study. The Arthritis Impact Measurement Scales 2 (AIMS 2) (Meenan & Mason, 1990), a self-administered questionnaire, was used to measure the impact of the disease on functional performance. The AIMS 2 includes 78 items divided into 12 scales. The scales relevant to arm and hand function—Hand and Finger Function, Arm Function, and Arthritis Pain—were administered as well as their corresponding Satisfaction scales. The demographics questionnaire of the AIMS 2 was also administered. The scaling properties, reliability, and validity of the AIMS 2 have been documented (Meenan, Mason, Anderson, Kazis, & Guc­cione, 1990).

A pain localization diagram displaying the 16 joints of the hand and wrist was developed for this study and...
used to identify location of pain. Subjects marked the joints where they experienced pain.

A calibrated Jamar Dynamometer\(^1\) was used to measure grip strength of the dominant and nondominant hands. Standardized positioning and instructions for testing were followed (Mathiowetz, Weber, Volland, & Kashman, 1984), and the mean of three trials was used for analysis.

A fourth measurement was a daily diary in which subjects recorded the percentage of time the splint had been worn, duration of morning stiffness (reported in hour and minutes from time of awakening until the stiffness wore off), change in medication, and unusual increase or decrease in activity level. Finally, a subjective splint rating form was administered for subjects to rate the splints for comfort, appearance, cleanliness, warmth, durability, ease of application, and perceived benefits.

Procedure

The following tests were administered before and after each experimental and control condition (a total of four measurement times), in the following order: the four 1-scales of the AIMS 2; pain localization diagram; and dynamometer testing. All testing was scheduled at the same time of day because pain varies with time of day (Huskisson, 1982). Subjects were instructed to wear the splint at night and record actual splint wear in the daily diary. At the end of each experimental condition, they completed the subjective rating for the splint worn. At the completion of the study, subjects identified whether they preferred the soft or the hard splint.

Data Analysis

One-way analyses of variances (ANOVAs) of repeated measures were used to test differences among conditions (i.e., pretest, control, soft splint, and hard splint) for the measurements listed in Table 1. Whenever significant effects \( (p < .05)\) were detected, Tukey’s tests were used to determine which conditions were significantly different from each other. Wilcoxon signed rank tests were used to compare the difference between the subjects’ ratings of the soft and hard splints (see Table 2). Finally, subject’s splint preference was analyzed descriptively with percentages.

Results

One subject refused to stop wearing the soft splint dur-

\(^1\)Jamar is manufactured by J. A. Preston, PO Box 89, Jackson, Michigan 49204.
ing the control period (her final experimental condition) to reduce hand pain; therefore, her data were excluded from data analysis of the control condition.

The ANOVAs revealed that for two scales of the AIMS 2 ( Finger and Hand Function and Arm Function) and for both grip measurements, there were no significant differences between the means (see Table 2). In contrast, results from the Arthritis Pain and Satisfaction Scales and the number of involved joints revealed significant differences among conditions. A Tukey's test indicated that arthritis pain was significantly less after both the soft and hard splint treatments compared with the pretest. The control period was not significantly different from the pretest or splinted periods. Another Tukey's test indicated that satisfaction was significantly better after all three experimental conditions compared with the pretest condition. A final Tukey's test indicated that the number of involved joints, as identified on the pain localization diagram, were significantly fewer after the soft splint condition than after the control condition. Further review of the pretest pain localization diagrams indicated that 74% of subjects identified wrist pain, 61% identified finger MCP joint pain, and 71% reported PIP joint pain. Less than 50% of subjects reported thumb or DIP joint pain.

Subject ratings of splints (soft splint versus hard splint) were compared with Wilcoxon signed rank tests (see Table 2). They rated the hard splint as significantly better on appearance and cleanliness than the soft splint and the soft splint as significantly better for relieving pain than the hard splint. In addition, more subjects indicated their intent to wear the soft splint for pain relief than the hard splint. Splint wear did not affect morning stiffness significantly. Splint wear compliance (splint worn at least 50% of the prescribed time) was found to be significantly higher for the soft splint (82%) than for the hard splint (67%). At the end of the study, 22 subjects (56%) indicated a preference for the soft splint, 13 (33%) preferred the hard splint, and 4 subjects (10%) preferred no splint. Current or previous splint wear was not related to preference for either the soft or the hard splint.

Discussion

Our study suggests that splints were effective for arthritis pain relief and that subjects were more likely to comply with wearing a soft splint than a hard splint for this purpose. With several soft splint options now available, persons with rheumatoid arthritis are able to select the best splint to relieve their pain.

Some subjects identified difficulty in using their hand at night while wearing either splint. By using splints to immobilize only involved joints, as advocated by Melvin (1982), the person is freer to perform tasks (e.g., pulling up blankets in bed) while still protecting painful joints. The majority of subjects in our study could have used a splint that provided wrist, MCP and PIP immobilization, leaving the thumbs and DIP joints free. Individualized splint prescription to eliminate immobilization of the uninvolved joints may be more appropriate in a clinical application of resting hand splints and more acceptable to clients.

The finding that arm and hand functions were not significantly affected by splint wear may be attributed to a lack of test sensitivity of the AIMS 2 for detecting small changes in hand function. Timed, standardized performance tests of hand function such as the Jebsen–Taylor Hand Function Test (Jebsen, Taylor, Trieschmann, Trott-

Table 1
One-Way Analysis of Variance of Repeated Measures

<table>
<thead>
<tr>
<th>Measurement</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIMS 2</td>
<td></td>
</tr>
<tr>
<td>Finger and Hand Function</td>
<td>1.54</td>
</tr>
<tr>
<td>Arm Function</td>
<td>1.25</td>
</tr>
<tr>
<td>Arthritis pain</td>
<td>6.69**</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>9.77***</td>
</tr>
<tr>
<td>Number of involved joints</td>
<td>3.62*</td>
</tr>
<tr>
<td>Grip strength (dominant—splinted hand)</td>
<td>98</td>
</tr>
<tr>
<td>Grip strength (nondominant—unsplinted hand)</td>
<td>.76</td>
</tr>
</tbody>
</table>

Note. n = 38
*p < .05
**p < .001
***p < .0001

Table 2
Comparison of Subjects' Rating of the Soft and Hard Splints

<table>
<thead>
<tr>
<th>Rating</th>
<th>p</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splint comfort</td>
<td>.9332</td>
<td>NS</td>
</tr>
<tr>
<td>Splint appearance</td>
<td>.0354*</td>
<td>Hard better than soft splint</td>
</tr>
<tr>
<td>Splint cleanliness</td>
<td>.0094**</td>
<td>Hard better than soft splint</td>
</tr>
<tr>
<td>Splint durability</td>
<td>1.0000</td>
<td>NS</td>
</tr>
<tr>
<td>Pain relief</td>
<td>.0413*</td>
<td>Soft better than hard splint</td>
</tr>
<tr>
<td>Reduction in morning stiffness</td>
<td>.2160</td>
<td>NS</td>
</tr>
<tr>
<td>Ease of putting on</td>
<td>.7476</td>
<td>NS</td>
</tr>
<tr>
<td>Splint comfort relative to temperature</td>
<td>.5784</td>
<td>NS</td>
</tr>
<tr>
<td>Effect of sleep</td>
<td>.4485</td>
<td>NS</td>
</tr>
<tr>
<td>Effect of family attitudes</td>
<td>.2900</td>
<td>NS</td>
</tr>
<tr>
<td>Intent to wear splint</td>
<td>.0285*</td>
<td>Soft more likely than hard splint to be worn</td>
</tr>
<tr>
<td>For pain relief</td>
<td></td>
<td></td>
</tr>
<tr>
<td>For relief of morning stiffness</td>
<td>.1621</td>
<td>NS</td>
</tr>
</tbody>
</table>

Note. n = 39, NS = not significant
*p < .05
**p < .01

The American Journal of Occupational Therapy
ter, & Howard, 1969) or the Arthritis Hand Function Test (Backman, Mackie, & Harris, 1991) may be more discriminating in assessing these changes. It is important to note that although no demonstrable change was found in hand function scales, subjects' satisfaction with hand function improved significantly after each splinted condition, and they reported that tasks were easier to perform when pain was reduced after splint wear.

Many subjects identified improved comfort with the soft splint compared with the hard splint, although this finding was not significant. Some subjects indicated that the soft splint was more effective in providing a feeling of protection around the joints because it wrapped around the hand. Some subjects stated that the circumferential cotton-padded wrap increased the warmth of the splint. Subjects who appreciated this feature tended to prefer the soft splint, whereas those who did not tended to prefer the hard splint. In a review of the literature on the use of heat and cold in the management of rheumatoid arthritis (Hayes, 1993), both heat and cold were found to reduce pain, muscle guarding, and stiffness while improving mobility, but overall heat was preferred, except during periods of inflammation. Although the warmth provided by the materials of the soft splint is not the same as therapeutic heat, further information on the client's degree of inflammation and his or her preference for heat or cold may contribute to selection of the most appropriate splint.

Cost is an important consideration in selecting the appropriate splint. The soft splint has the extra expense of the soft wrap, eliminating the need for application of hook-and-loop straps. Durability should be considered in long-term splint use. Although subjects rated the hard splint better in durability, this factor did not affect their preference as much as others. Because soft splints are relatively new, their durability has not been fully evaluated. It may be interesting to ask clients with rheumatoid arthritis how much they would be willing to pay for their preferred splint to determine whether the perceived benefits warrant the expense.

Because of the relatively short-term treatment periods (28 days), splint wear compliance may have been higher than that which would occur in long-term use. In addition, no transition days were included between conditions, which may have contributed to a carryover effect of pain relief related to splint wear. However, because of the randomized sequence of treatments, any carryover should have had a minimal effect. The relatively short treatment periods may have also limited the potential for any significant changes in hand function. We selected this limited treatment period to eliminate seasonal influences on pain and stiffness. Feinberg (1992) also used 28-day treatment periods in her resting hand splint study on therapist–client interaction. A longer study would help determine whether splint compliance decreases over time.

We did not include other identified compliance-enhancing strategies such as knowledge of splint benefits (Nicholas et al., 1982) or therapist–client interaction (Feinberg, 1992). However, the combination of these strategies with the client's preferred splint might further increase splint compliance and the beneficial effects of splinting. Groth and Wulf (1995) recommended a combination of strategies to improve compliance in hand rehabilitation. Their recommendations included addressing the source of client dissatisfaction, application of learning principles, education, reduced complexity of regimens, and promotion of self-management.

Compliance has also been identified as a major problem interfering with treatment efficacy and clinical outcomes in children with rheumatoid arthritis (Rapoff, 1989). Offering soft splint options may be especially beneficial in enhancing compliance and splint efficacy with pediatric rheumatic diseases where long-term splint wear is often recommended to minimize deformities.

Summary

The results of our study provide some evidence that both soft and hard splints contribute to a reduction of arthritis pain. Fewer joints were identified as painful after the soft splint treatment relative to the no treatment period, lending support for use of the soft splint. In addition, subjects rated the soft splint as better in reducing pain and indicated their intent to wear the soft splint more often for pain relief. Pain relief is an important outcome measure, and it is a major goal of arthritis treatment; therefore, it may have a greater effect on splint compliance and preference than other factors, such as cleanliness and appearance of splint. Hand function, as measured by grip strength and AIMS 2 scales, was not affected by resting hand splint use. The splint wear compliance with the soft splint was significantly better than that with the hard splint or that reported in previous splint studies (Belcon et al., 1984; Feinberg & Brandt, 1981).

Although the overall results favor the soft splint, some subjects preferred the hard splint or no splint. Therefore, we cannot assume that splinting will benefit all clients with rheumatoid arthritis or that one particular splint is best for every client's needs. Input from the client, combined with individualized recommendations and a range of splint options, may enhance splint wear compliance and the beneficial effects achieved from splinting. Client satisfaction is an essential component to
successful splinting and an important outcome measure. Therapists are encouraged to provide options to their clients, with attention to comfort and preference to ensure satisfaction and to enhance compliance with treatment interventions. ▲

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