Abstract

Objective: To identify hand function problems and the reasons for choosing a specific finger splint in patients with rheumatoid arthritis (RA) and swan neck deformities.

Methods: A qualitative study was performed alongside a randomized, controlled cross-over trial comparing the effectiveness of two types of finger splints (the silver ring splint [SRS] and the prefabricated thermoplastic splint [PTS]) in 50 patients with RA and swan neck deformities. Questions on the patients’ main hand function problem and reasons for choosing a specific splint type were performed at baseline and after using each splint. The qualitative analyses included the identification of meaning units and (sub)concepts related to hand function problems and splint preferences.

Results: RA patients with swan neck deformities experience problems with flexion initiation, painful proximal interphalangeal joint hyperextension, grip activities and comprehensive hand function activities. Reasons for preferring or not preferring a specific type of finger splint included: effect, ease of use, appearance, comfort and side effects. Apart from the splint slipping off and a negative attitude towards the appearance of the splint, which appeared to be more frequently mentioned in connection with the SRS, no clear pattern of positive or negative appreciation of either type of splint could be distinguished.

Conclusion: RA patients with swan neck deformities experience a variety of problems, including impairments in functions and limitations in daily activities. With the prescription of finger splints, a substantial number of potentially positive and negative consequences of their use need to be taken into account. Copyright © 2010 John Wiley & Sons, Ltd.

Keywords

Rheumatoid arthritis; swan neck deformity; finger splint

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Finger Splints for Swan Neck Deformities in RA

van der Giesen et al.

**Introduction**

Hand function disability is common in patients with rheumatoid arthritis (RA) (Maini and Feldman, 1998). Local inflammation initially causes pain, swelling and a limited range of movement. As the disease progresses, instability of the joints may result in specific wrist and finger deformities. In the wrist, ulnar and volar translation of the carpus in relation to the radius may be observed, shortening the skeletal structure. Other common deformities in RA include ulnar deviation of the metacarpophalangeal (MCP) joints, Z-deformation of the thumb and Boutonnière and swan neck deformities of the fingers. The Z-deformation of the thumb is characterized by flexion of the MCP joint and hyperextension of the interphalangeal (IP) joint, and may limit the ability actively to flex the IP joint. A Boutonnière deformity of the finger is defined by flexion of the proximal interphalangeal (PIP) joint and extension of the distal interphalangeal (DIP) joint, limiting the active extension of the PIP joint. A swan neck deformity (Figure 1) is characterized by hyperextension of the PIP joint and flexion of the DIP joint, caused by a dominance of the extensor apparatus, which is not counteracted by flexion forces. The swan neck deformity, either fixed or flexible, may limit the ability actively to flex the PIP joint, with negative consequences for performing a pinch grip and grasping larger objects with one hand (Tubiana, 1993).

There has only been one study that has specifically addressed the impact of swan neck deformities (Vliet Vlieland et al., 1996). This study concluded that the presence of swan neck deformities is moderately correlated with the observed hand function.

The application of finger splints is one of the treatment modalities that can be provided for finger deformities such as swan neck deformities. A number of studies have demonstrated that finger splints can enhance hand function in patients with RA and swan neck deformities (Schegget and Knipping, 2000; van der Giesen et al., 2009; Zijlstra et al., 2004). Currently, various types of finger splints are available, including silver ring splints (SRS), prefabricated thermoplastic splints (PTS) and custom-made thermoplastic splints (CTS). Studies comparing SRS with CTS (Schegget et al., 2000) or PTS (van der Giesen et al., 2009) showed overall similar clinical effectiveness.

Until now, patients’ experiences with swan neck finger splints have not been extensively investigated. It has been found that patient satisfaction with CTS was lower than with SRS (Schegget et al., 2000), whereas overall patient satisfaction with PTS was equal to SRS (van der Giesen et al., 2009). In addition, Zijlstra et al. (2004) reported a number of side effects, including paraesthesia in the fingertips, development of rheumatoid nodules, unpleasant pressure on bony joint edges and an uncomfortable sensation, in patients using SRS for a variety of finger deformities.

The aims of this study were therefore 1) to ask patients with RA and swan neck deformities about the difficulties in hand function they experienced and 2) to ask patients with RA and swan neck deformities about their reasons for choosing or not choosing a specific type of finger splint.

**Methods**

**Study design**

In this study, a qualitative methodology was used, based on elements of the phenomenographic approach (Carr et al., 2003; Hewlett et al., 2001). Phenomenography can be used to identify variations in people’s understanding of phenomena which they experience in the world around them (Bergsten et al., 2009; Marton and Booth, 1997; Morton, 1981; Sjostrom and Dahlgren, 2002; Wikstrom et al., 2005).

The data used in this study were collected alongside a multi-centre, randomized, cross-over trial, in which two finger splints were compared in patients with RA who had at least one swan neck deformity (van der Giesen et al., 2009). For the present study, we collected additional data at baseline (difficulties experienced by patients) and directly after the patients had worn both splints for four weeks (patients’ reasons for choosing or not choosing a specific type of splint).
Participants

From August 2005 to September 2006, consecutive patients with RA and swan neck deformities were recruited at the outpatient rheumatology clinics of three centres in the Netherlands: Leiden University Medical Center (Leiden), Sint Maartenskliniek (Nijmegen) and Reinier de Graaf Gasthuis (Delft).

Patients were eligible for the study if they had RA according to 1987 American Rheumatism Association (ARA) criteria (Arnett et al., 1988), were at least 18 years old and had at least one swan neck deformity of the second or third finger on one or both hands, manually correctable to 45 degrees of PIP flexion or more. In addition, patients had to satisfy the following criteria: to have a stable level of disease activity, to have received no corticosteroid injections in the previous three months, to have no planned surgery for the duration of the study and not to have been treated with swan neck finger splints in the past.

Exclusion criteria were the presence of a condition other than RA or severe other finger deformities interfering with hand function or with the use of finger splints.

The study was approved by the medical ethics committees of all three hospitals, and all participants gave written informed consent.

Intervention

In this study, patients used two types of finger splints: SRS (SIRIS™ swan neck splint, Silver Ring Splint Company, Charlottesville, VA, USA) and PTS (Oval-8® finger splint, 3-Point Products, Inc., Stevensville, MD, USA) for four weeks in succession, with a washout period of two weeks in between. The order in which the splints were used was randomized.

SRS are made of sterling silver and manufactured according to the patient's ring size. The maximum allowed extension of the PIP joint can be individually adjusted by bending the splint within material limits. SRS cost approximately £68.78 (€80) each. PTS are available in kits containing numerous sizes, with minimal time required for individual adjustments. They cost approximately £12.90 (€15), exclusive of the cost of therapist time (Manning, 2003). In this study, the costs of the SRS were fully reimbursed by the patients' health insurance companies, whereas the costs of the PTS were covered by the Dutch Arthritis Association.

The intervention was performed in the rheumatology outpatient clinics of the three centres by two hand therapists (F.J.G., C.K.S.) with experience (more than five years) in the field of rheumatology. Prior to the study, an intervention guideline was developed to ensure uniformity in performing the intervention. This included the following details: all correctable swan neck deformities of the second and third finger of both hands were splinted. Both type of splints were sized according to the manufacturer's recommendations and fitted in slight flexion, correcting the hyperextension of the PIP joint. Participants were advised to wear the splints as much as possible, even at night, removing them only for cleaning. Moreover, patients were asked to perform their usual routine of activities, but advised not to undertake any extra therapeutic exercises which had not been part of their routine prior to the splinting intervention. Patients were further told that adverse effects such as pain, swelling or tingling fingertips were rare. In the event of adverse effects, they were advised to contact their treating therapist.

Measurements

Data were collected at baseline and after using both splints (10 weeks after baseline). Data collected at baseline included sociodemographic and disease characteristics, hand function, swan neck and treatment characteristics, and the identification of the main hand function problem. The measurements at 10 weeks, after using both splints, consisted of recording patients' preferences for a splint and the reasons for choosing the preferred splint.

All assessments were conducted by the two hand therapists who provided the intervention.

Hand function

Hand function was assessed by the sequential occupational dexterity assessment (SODA) (van Lankveld et al., 1996, 1999, 2000). With the SODA, the patient performs 12 standardized tasks (six unilateral, six bilateral). An assessor scores the ability to perform every task (4 = able to perform in the requested way; 1 = able to perform in a different way; 0 = unable to perform) and the level of difficulty in the performance (2 = not difficult; 1 = some difficulty; 0 = very difficult). For bilateral tasks, each hand is scored separately. The SODA score ranges from 0–108, with a higher number indicating better hand function.
Swan neck and treatment characteristics

Swan neck and treatment characteristics included the passive PIP joint hyperextension of the splinted fingers, which was measured unsplinted using a finger joint goniometer, in degrees (American Academy of Orthopedic Surgeons, 1980). For this purpose, the finger was placed manually in maximum hyperextension, with the goniometer placed on the volar side of the finger. In case of multiple swan neck deformities, the average of the scores of the fingers involved was used.

In addition, the number of splints provided and the adherence to the splints was assessed with a diary, in which the participants recorded the number of hours per day that they used the splint(s).

Identification of main hand function problems and reasons for preferring a specific splint type

To identify the main difficulty in hand function that patients with swan neck deformities experience and to explore the reasons for choosing the preferred splint, patients were questioned at baseline and at 10 weeks (after using both splints). The main difficulties encountered in patients with swan neck deformities were identified by asking patients: ‘What is the main difficulty you experience because of the swan neck deformity(ies)?’. The reasons for preferring one of the two splints was identified by asking patients: ‘You have just indicated that you prefer the ... (name of the splint) splint. What are the reasons for preferring this type of splint?’.

In both cases, administering the questions was neither timed nor taped, but patients’ responses were written verbatim, directly onto the patient record form. The administration of the two questions was pilot tested in five patients with at least one swan neck deformity who had used more than one finger splint, and proved to elicit a main problem and at least one reason for preferring a specific splint type in all of them.

Data analysis

Categorical data were expressed as numbers with percentages, while continuous data were expressed as medians with interquartile ranges (IQR) or as means with standard deviations (SD).

The data for the two personally administered questions were analysed using meaning condensation (Kvale, 1996).

Data analysis of question 1 (hand function problems)

The transcribed answers to the open-ended question were all read to gain an overview. The answers were divided into meaning units. A meaning unit was defined as a specific unit of text, either a few words or a few sentences with a common problem-related theme (Karlsson, 1995) (e.g. ‘I have great difficulties when I have to fasten small buttons on a shirt’). Hand function-related sub-concepts in the meaning unit were identified (i.e. handling small buttons). The sub-concepts were organized and grouped according to their meaning, to yield broader hand function-specific concepts (i.e. small grip activities). A concept was defined as a separate meaningful hand function-related problem distinct from other problems, while sub-concepts share the attributes of a broader hand function-related concept and were therefore subordinate to this concept (Kvale, 1996).

To place the difficulties that the patients experienced in the broad perspective of individual functioning, the sub-concepts and hand function-specific concepts were linked to the International Classification of Functioning, Disability and Health (ICF), which is a worldwide accepted model providing a universal language for the description and classification of functioning (Stucki, 2005). Each concept and sub-concept was linked to the ICF category according to linking rules (Stamm et al., 2005, 2007). According to these linking rules, each concept and sub-concept was linked to the appropriate ICF category according to published linking rules (Cieza et al., 2002, 2005) previously used in qualitative studies (Coenen et al., 2006; Stamm et al., 2005, 2007). According to these linking rules, each concept is linked to the ICF category that reflects its content most accurately. For example, ‘handling small buttons’ was linked to the ICF category d540: ‘Dressing’ in the ‘activities and participation’ component. If a concept could not be linked to the ICF classification, this concept was designated as ‘not covered’ (NC). If there was insufficient information for making the decision about the precise ICF category, the concept was considered ‘not defined’ (ND) in the ICF classification. In addition to the use of the previously mentioned linking rules, the two investigators (F.J.G. and T.V.V.) discussed the linking of the concepts and sub-concepts to the ICF categories until consensus was achieved.
The same process as in question 1 was used, and meaning units were identified. In addition, the meaning units were then labelled as positive or negative experiences. Finally, their frequency in connection with either type of splint was counted.

Both analyses were performed by two researchers (F.J.G. and T.V.V.) experienced in qualitative research and clinical care for patients with hand function problems in rheumatic diseases.

Results

Fifty participants were included in the study (Figure 2). Table 1 shows the characteristics of the study sample. The large majority were middle-aged women, with a median disease duration of 13.7 years. According to the SODA, their hand function was limited. More than two-thirds of the population (70%) had two or more swan neck deformities of the second or third finger and consequently received two or more finger splints.

Patients’ main difficulties in hand function

Table 2 shows the main hand function difficulties in 44 patients with RA and swan neck deformities. Six of the

Table 1. Characteristics of 50 RA patients with swan neck deformities treated with two types of finger splints

<table>
<thead>
<tr>
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<th>9/41</th>
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<tbody>
<tr>
<td>Sex, No. (m/f)</td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td>53.8 (44.9–66.4)</td>
</tr>
<tr>
<td>Paid employment, No. (%)</td>
<td>13 (26)</td>
</tr>
<tr>
<td>Disease duration, years</td>
<td>13.7 (8.6–20.1)</td>
</tr>
<tr>
<td>SODA (0–108)</td>
<td>84.5 (71.3–97.3)</td>
</tr>
<tr>
<td>PIP joint hyperextension, degrees</td>
<td>23.8 (20–30)</td>
</tr>
<tr>
<td>Swan neck deformities per patient on second and/or third finger on one or both hands, No. (%)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>18 (36)</td>
</tr>
<tr>
<td>2</td>
<td>17 (34)</td>
</tr>
<tr>
<td>3</td>
<td>2 (4)</td>
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<tr>
<td>4</td>
<td>13 (26)</td>
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<tr>
<td>Finger splints per patient (1–4)</td>
<td>2 (1–3)</td>
</tr>
</tbody>
</table>

Values are expressed as median (interquartile range) unless otherwise indicated.

50 patients were not able to formulate at least one problem. From the difficulties mentioned by the 44 remaining patients, meaning units were extracted, from which 22 hand function-related sub-concepts were identified. These sub-concepts were grouped into seven hand function-specific concepts, as described below.

Flexion initiation

A difficulty was classified under ‘flexion initiation’ if the patient sometimes or always had an inability or
difficulty in actively flexing the PIP joint without the help of the thumb or the other hand: ‘My biggest difficulty is that sometimes my middle finger refuses to bend. It becomes stiff in a way. Not the stiffness I have in the morning, but rather a total stiffness.’ (Patient number [Pt no] 6, 58-year-old woman with a disease duration of eight years and one swan neck deformity with 20 degrees of PIP joint hyperextension).

**Painful PIP joint hyperextension**

If painful PIP joint hyperextension could not actively be avoided during the use of the hand, the problem was classified under ‘painful PIP joint hyperextension instability’: ‘I find it most annoying that this hinge hurts [points at the PIP joint of the left index finger] when it is bent the wrong way.’ (Pt no 21, 72-year-old woman with a disease duration of 21 years and one swan neck deformity with 40 degrees of PIP joint hyperextension).

**Appearance**

A problem was classified under ‘appearance’ if the appearance of the finger was bothering the patient: ‘Well, look at my fingers! This is not something to be proud of, is it?’ (Pt no 17, 41-year-old woman with a disease duration of 18 years and four swan neck deformities with an average of 37 degrees of PIP joint hyperextension).

**Small grip activities**

This concept emerged from activities usually involving two- or three-point grips: ‘What I find difficult is...
buttoning the smallest buttons of a shirt.’ (Pt no 10, 68-year-old woman with a disease duration of two years and two swan neck deformities with an average of 30 degrees of PIP joint hyperextension).

**Big grip activities**

Activities involving grips with multiple fingers are captured under ‘big grip activities’: ‘I think it bothers me the most in grabbing a can of soda, as I can’t put my fingers all around it.’ (Pt no 19, 57-year-old man with a disease duration of 24 years and two swan neck deformities with an average of 30 degrees of PIP joint hyperextension).

**Activities involving the application of pressure**

This concept comprises problems related to pushing or pressing with the fingertips: ‘On some cash machines you have to press the buttons too firmly and I can’t manage that with my fingers so I have to use my thumb.’ (Pt no 15, 59-year-old woman with a disease duration of 26 years and one swan neck deformity with 30 degrees of PIP joint hyperextension).

**Comprehensive hand function activities**

‘Comprehensive hand function activities’ involve activities using multiple grips: ‘I have difficulties doing my daughter’s hair with a rubber band. I feel I lack enough force.’ (Pt no 44, 39-year-old woman with a disease duration of eight years and one swan neck deformity with 10 degrees of PIP joint hyperextension).

From the seven hand function-specific concepts, three could be linked to the ICF ‘body functions’ and ‘body structures’ component and four to the ICF ‘activities and participation’ component. One concept (‘flexion initiation problem’) was not covered by the ICF and three concepts (‘small grip activities’, ‘pressure applying activities’ and ‘comprehensive hand function activities’) were not definable in the ICF.

**Patients’ reasons for choosing or not choosing a specific splint**

The mean ± SD adherence rates of the SRS (15.3 ± 7.4 hours/week) and the PTS (15.4 ± 7.4 hours/week) were found to be similar (difference −0.05, 95% confidence interval [CI] −2.1; 1.9).

Table 3 shows that after wearing each splint for four weeks, 24 patients chose the SRS and 21 patients the PTS, whereas two patients were not able to decide between them.

From patients’ statements regarding their reason to prefer a specific splint type, 95 meaning units were identified (56 positively stated and 39 negatively stated). These meaning units were categorized into four positive aspects and seven negative aspects.

Positively stated meaning units were categorized into ‘effect’ (positive impact on hand function or pain), ‘ease of use’ (putting the splint on or off and cleaning the splint), ‘appearance’ and ‘comfort of wearing’.

Negatively stated meaning units covered four aspects that were designated as ‘side effects’: ‘sharp edges’, ‘sweating’, ‘pain of the finger adjacent to the splinted finger due to friction’ and ‘paraesthesiae’, such as numbness or tingling of the tip of the splinted finger. In addition, two more practical aspects included: ‘the splint slipping off’ and ‘change of fit during wear’, and one aspect included the appearance of the splint. The 24 patients preferring SRS mentioned 32 positive aspects regarding the SRS and 13 negative aspects pertaining to PTS. The 21 patients choosing PTS reported...
24 positive aspects regarding PTS and 26 negative aspects regarding SRS. The distribution of the various meaning units derived from patients' experiences over the two splints is presented in Table 3. The largest differences with respect to numbers of statements with either splint pertained to 'the splint slipping off', which was reported three times with PTS in patients preferring SRS and 10 times with SRS in patients preferring PTS, and to a negative appreciation of 'appearance', which was not mentioned with PTS in patients preferring SRS but was mentioned 10 times with SRS in patients preferring PTS.

Discussion

The current study showed that hand function problems in RA patients with swan neck deformities encounter could be categorized into seven hand function problem-related concepts. The majority of the concepts concerned the ICF component 'activities and participation'. Only three concepts could be linked to the ICF, indicating the limited value of the ICF in classifying hand function problems in RA patients with swan neck deformities. The numbers of patients choosing SRS or PTS after wearing them both for four weeks were almost evenly distributed. Four positive aspects and seven negative aspects of the splints were identified as reasons for patients to prefer or not to prefer a specific splint type.

Apart from identifying hand function problems experienced by patients themselves, this study aimed to link the derived hand function-related concepts to the ICF. It was, however, found that the ICF was not sufficiently detailed to describe four of the seven hand function-related concepts that were identified in our study. These four concepts were related to certain grips and were likely to be too specific to incorporate in a generic model of functioning such as the ICF. In addition to more generic hand function-related concepts, these condition-specific concepts can be used to support healthcare providers with appropriate history taking and physical examination and the development of condition-specific outcome measures in RA patients with swan neck deformities.

With respect to reasons why patients with swan neck deformities prefer a specific finger splint over another, no overall clear pattern of positive or negative appreciation of either SRS or PTS could be distinguished. In a previous study comparing SRS with CTS (Schegget and Knipping, 2000), SRS was preferred over CTS with respect to comfort and appearance.

Side effects were reported with both types of splints in our study. In the study by Schegget and Knipping (2000), no detrimental experiences regarding the skin were mentioned. Zijlstra et al. (2004), however, observed the development of rheumatoid nodules on the PIP joint, which prevented the SRS from passing the joint, and also reported on 'pressure on bony edges' and 'paraesthesiae' as reasons for patients to discard the use of SRS. In the randomized controlled trial connected to this qualitative study (van der Giesen et al., 2009), side effects including skin abrasions due to a high pressure with the SRS were reported by one person as a reason to decline further participation in that study.

This study had a number of limitations. First, the qualitative method used to identify patients' problems did not comprise a formal analysis of saturation. In addition, patients were asked to prioritize their problems, with only the main difficulty being recorded. Therefore, it can not be ruled out that more problems due to swan neck deformities can be identified.

Second, patients were not selected based on the maximum variation strategy (Patton, 1990), which should ensure the inclusion of a maximum variation of patients based on socioeconomic, demographic and disease characteristics. The results of this study can therefore not be generalized to all patients with RA and swan neck deformities who have used finger splints.

Third, the elicitation of positive and negative experiences with either splint was connected to patients' preferences. It cannot be ruled out that by systematically asking patients about positive and negative experiences with both splints, other experiences would have been derived.

Fourth, due to limited resources, we were not able to employ independent assessors who were not involved in the treatment. This might have introduced potential bias regarding the outcome of the interviews.

With respect to daily clinical practice, the hand function-related concepts that were identified in this study could guide clinicians’ history-taking and clinical examination. Concerning patients' views on the usage of finger splints, previous studies have predominantly focused on appearance (Schegget and Knipping, 2000), suggesting the superiority of SRS in this respect. The variety of positive and negative experiences with wearing finger splints, as identified in the present study,
can help clinicians in discussing with patients all the advantages and disadvantages of various types of finger splints. Although costs were not the focus of the present study, they could also be considered in the prescription process. Taking into account that the available evidence points to a similar clinical effectiveness of SRS and TPS, and that positive and negative appreciations are seen with both types of splint, it seems sensible to inform patients about the characteristics of both types of splints and advise them to try the PTS first. If they are found to be effective, patients can decide at a later stage whether or not to continue with the PTS or switch to SRS.

Acknowledgement

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