ORIGINAL REPORT

PREVALENCE OF HAND SYMPTOMS, IMPAIRMENTS AND ACTIVITY LIMITATIONS IN RHEUMATOID ARTHRITIS IN RELATION TO DISEASE DURATION

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Objective: To determine the prevalence of hand and wrist symptoms and impairments, and the resulting activity limitations in relation to disease duration in patients with rheumatoid arthritis.

Design and patients: A cross-sectional study included 200 consecutive patients with rheumatoid arthritis in 4 categories of disease duration: 2–4, 4–6, 6–8 and ≥8 years. Patients were asked about the presence of various hand and wrist symptoms, and underwent a standardized physical examination. To evaluate activity limitations, patients completed the Disabilities of the Arm Shoulder and Hand questionnaire and scored their limitations on a Numerical Rating Scale (0 = no to 10 = maximum limitation).

Results: Of all patients, 94% suffered from at least one symptom, and 67% had at least one impairment, mostly from the earliest stages onwards. The median standardized Disabilities of the Arm Shoulder and Hand score (interquartile range) was 26.7 (10.8–42.5). The mean Numerical Rating Scale score for activity limitations was 2.99 (standard deviation 2.50) in the dominant hand and 2.59 (standard deviation 2.49) in the non-dominant hand.

Conclusion: A high prevalence of hand and wrist symptoms and impairments is often already present after 2 years of disease duration. We recommend that physicians specifically screen for these symptoms and impairments, starting 2 years after the diagnosis of rheumatoid arthritis.

Key words: rheumatoid arthritis; hand; symptoms and impairments.

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INTRODUCTION

In the early stages of rheumatoid arthritis (RA) involvement of the hand and wrist is commonly described, causing pain, limited range of motion and/or loss of muscle strength. Previous studies have reported 28% hand involvement and 8% wrist involvement at the onset of the disease (1–3). In a small cohort of patients with early onset arthritis metacarpophalangeal (MCP) joint or wrist deformities were observed by magnetic resonance imaging in approximately 90% of the patients (4). Data prior to 2000 show that, during the course of the disease, 90% of RA patients eventually develop hand deformities (1, 5). However, this percentage is likely to decrease with the advent of more effective pharmacological treatment regimens that can be started early in the course of the disease (6).

Synovitis and tenosynovitis are the first symptoms (4), which may eventually result in the destruction of joints, laxity of ligaments and imbalance of muscle function. As this process progresses over time, impairments reinforce each other in such a way that serious deformities can eventually develop, and these can lead to limitations in activities of daily living. However, we lack information concerning the precise course of such deteriorations. It is important to gain insight into the sequence of these early symptoms in the hand and wrist and how they develop over time, in order to provide adequate non-pharmacological treatment, i.e. exercises, massage and information on hand-use, in combination with splinting, injection therapy or surgical interventions.

In addition to the lack of knowledge about hand and wrist impairments, little is known about the resulting activity limitations. With more knowledge it might be possible to design a screening protocol to aid the development of a therapeutic or preventive non-pharmacological intervention, which could then be tested in a randomized trial.

As a first step we performed a cross-sectional study within an ongoing longitudinal cohort study, to determine the prevalence of hand and wrist symptoms, impairments, and activity limitations in relation to disease duration in patients with RA after the establishment of adequate pharmacological treatment.

PATIENTS AND METHODS

Patients

In this cross-sectional study, the study population consisted of consecutive patients from an ongoing care and research cohort: the Early Arthritis Clinic (EAC) of the Jan van Breemen Institute in Amsterdam, a large clinic for rheumatology and rehabilitation medicine in the Netherlands. The EAC provides an extensive source of data in which

all patients ≥ 18 years of age, with arthritis in ≥ 2 joints and ≤ 3 years of symptoms have been monitored since 1995 with regular follow-up visits. The inclusion criteria for the present study were, EAC patients, fulfilling the American College of Rheumatology criteria for RA (7) at baseline and/or 1 year after inclusion in the cohort, and at least 2 years of follow-up in this cohort. Patients with spondylarthropathy, reactive arthritis, crystal-induced arthropathy, systemic lupus erythematosus, Sjögren's syndrome or osteoarthritis were excluded.

Patients were included in 4 categories of disease duration: 2–4 years, 4–6 years, 6–8 years and ≥ 8 years, and were invited to attend our Department of Rehabilitation Medicine. Patients with a disease duration of less than 2 years were not included, because the first 2 years are considered to be necessary to establish adequate pharmacological treatment. In patients with a disease duration of more than 2 years, we chose 4 categories with small intervals of disease duration (i.e. 2 years), because we wanted to know at what moment in time hand problems arise. Recruitment continued until 50 patients were included in each subgroup of disease duration, with a total of 200 patients. The reasons patients gave for non-participation were registered. All participants gave written informed consent, and the study protocol was approved by the local medical ethics committee.

Disease information

Data concerning disease duration, the nearest scores at the time of assessment of the disease activity (Disease Activity Score in 28 joints: DAS28) (8) and radiographically determined joint damage (Sharp van der Heijde score: SHS) (9) were collected from the EAC database. Also collected from this database was the nearest score at the time of assessment for the Dutch version of the Health Assessment Questionnaire (HAQ), together with the category score for HAQ-grip (10, 11).

Symptoms

The patients were asked about the presence or absence of various hand and wrist symptoms that bothered them: pain, stiffness, muscle weakness, paraesthesia, limited fist, limited pinch grip, joint deviation, aesthetics, or other complaints. Furthermore, pain was assessed according to a Numerical Rating Scale (NRS) ranging from 0–10 (0 = no pain at all, 10 = unbearable pain).

Impairments

A standardized physical examination of the hand and wrist was performed to test for joint mobility, any dislocation or deviation of joints, tendon-gliding, signs of (teno)synovitis, and nerve function (12). Joint mobility was considered to be impaired if the passive measurement was ≥ 15 degrees less than the norm values (13–15). Involvement of the first carpometacarpal (CMC-1) joint was scored positive if passive motion of this joint was painful, and when the CMC-1 joint was prominent during inspection of the hand contour. Z-deformity of the thumb was scored positive if, on inspection, there was a flexed MCP-1 joint and a hyperextended interphalangeal joint that could not be actively corrected. Flexor tendon-gliding was graded with the Amsterdam Severity Scale in Stenosing Tenosynovitis (range 0–3) because of its high inter-observer reliability (16). Tenosynovitis ≥ grade 2 was considered to indicate impairment, in which a perceptible click or a reduced tempo of active finger flexion was observed, in combination with a full active range of motion (aROM) (determined by the maximum pROM). Grade 3 indicates a restriction in aROM due to tendon blockade under the pulleys or within the tendon sheath. A swollen extensor tendon sheath with palpation was interpreted as tendinitis in this tendon. Nerve function, focused on signs of carpal tunnel syndrome (CTS), was assessed with the Hoffman-Tinel test and the Phalen manoeuvre (17).

A total of 182 patients underwent a physical examination, performed by one of two rehabilitation physicians (NCAH and AFH). The physical examination of 18 patients was independently performed by both assessors on the same day, to assess for inter-observer reliability (inter-rater agreement was 88%, ranging from 78% to 94% for the different impairments).

Activity limitations

The patients completed the validated Dutch version of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire to measure self-rated upper-extremity disability and symptoms (18–20). The DASH is a 30-item questionnaire assessing ability to perform activities of daily living (ADL), limitations in social activities, pain, sleep, and self-consciousness. Each item is scored on a scale ranging from 1 ("no problem at all") to 5 ("impossible to perform this activity"), and the summed scores are transformed to a standardized score (0–100), with higher scores indicating more limitations. Furthermore, patient-reported activity limitations were assessed according to an NRS, ranging from 0–10 (0 = no activity limitations, 10 = severe activity limitations), when asked "how do you describe your ability to use your hands in daily activities".

Statistical analysis

The mean age and median disease duration were calculated at the time of assessment and percentages were calculated to determine the prevalence of presence of symptoms and impairments. For the assessment of activity limitations, the mean standardized DASH score (21) and the mean NRS score for use of the hands were calculated. A distinction was made between the dominant hand and the non-dominant hand. Differences between the 4 disease duration groups were investigated with a χ^2 test for trend (dichotomous variables) or an one-way analysis of variance (other variables). In a secondary analysis, differences between patients with a disease duration of < 8 years and ≥ 8 years were investigated with an χ^2 test (dichotomous variables) or a 1-way analysis of variance (other variables). p-values of ≤ 0.05 were considered to be statistically significant, and all analyses were performed with SPSS version 15.0 (SPSS, Chicago, IL, USA).

RESULTS

Patients

A total of 366 patients were invited to participate, 166 of whom were unwilling to participate after receiving an invitation for the assessment. Their reasons for non-participation were: logistical problems (19%), no specific reason (51%), no hand symptoms (2%), or no reason given (28%). The characteristics of the participants and the non-participants are presented in Table I. The two groups were comparable with regard to gender, marital status, mean disease duration, IgM-rheumatoid factor positivity, anti-cyclic citrullinated peptide (aCCP) positivity, SHS, DAS28, HAQ and HAQ-grip. The participants were statistically significantly older, and tended to have a slightly higher DAS28 score than the non-participants.

Symptoms

The full results are presented in Table II. A total of 94% of the patients suffered from at least one hand or wrist symptom after 2–4 years of disease duration. The symptoms that patients described most frequently were pain, stiffness of the hand, muscle weakness, paraesthesia, and complaints concerning a limited fist. In general, no associations were found between symptoms and disease duration, except for stiffness of the hand, which patients experienced less with longer disease duration. Mean

Table I. *Patient characteristics*

Characteristics	Participants $n=200$	Non-participants $n=166$
Age, years, mean (SD)	59.7 (10.7)	55.8 (13.8)
Female, %	75	68
Marital status		
Married/living together,%	67	71
Single/divorced, %	23	21
Widow(er), %	5	7
Unknown	5	1
Disease duration, years, mean (SD)	5.9 (2.7)	5.4 (3.2)
Rheumatoid factor positive, %	48	48
aCCP positive, %	58	60
Sharp van der Heijde score, median (IQR)	6 (0–25)	4 (0–11)
DAS28, mean (SD)	3.12 (1.50)	2.82 (1.24)
HAQ, median (IQR)	0.75 (0.13–1.25)	0.75 (0.13–0.88)
HAQ-grip: presence of difficulty with grip, %	44	45

Differences between participants and non-participants were tested with a *t*-test (variables normally distributed), a Mann-Whitney *U* test (variables not normal distributed) or a χ² test (categorical).
SD: standard deviation; aCCP: anti-cyclic citrullinated peptide; IQR: inter-quartile range; DAS28: Disease Activity Score of 28 joints; HAQ: Health Assessment Questionnaire.

and standard deviation (SD) NRS pain was 2.54 (SD 2.29) in the dominant hand and 2.11 (SD 2.19) in the non-dominant hand. Pain was not related to disease duration.

Impairments

The results are presented in Table III. After 2–4 years of disease duration 70% of the patients were found, during the physical examination, to have at least one hand or wrist impairment in the dominant hand. This was found in the non-dominant hand in 66% of the patients. The most frequently found impairments were a limited passive range of motion (pROM) of the wrist and finger joints, stenosing tenosynovitis, and involvement of the CMC-1 joint. In 6% of the patients there were signs of CTS in the dominant hand and in 8% in the non-dominant hand. Table III shows how these impairments were associated with disease duration. When comparing the sub-groups of disease duration, with the χ² test for trend, there was a significantly higher prevalence of the following: limited pROM of finger joints in the dominant hand, Z-deformity of the non-dominant thumb, and tendinitis of the extensor tendons of the dominant hand in the sub-groups with a longer disease duration. There was also a significantly higher prevalence of limited pROM of finger joints in the non-dominant hand in the sub-group of patients with 8 or more years of disease duration, compared with the combined prevalence in the first 3 subgroups of disease duration.

Activity limitations

The median and interquartile range (IQR) standardized DASH score for all the included patients was 26.7 (IQR10.8–42.5). This is significantly higher than the normative DASH score for the general population, which is 10.1 (SD 14.7) (22). The DASH score was classified as abnormal if it was above the normative mean DASH score plus twice the SD (>39.5). A total 30% of the patients had an abnormal DASH score. The mean (SD) NRS use of hands for all the included patients was 2.99 (SD 2.50) in the dominant hand and 2.59 (SD 2.49) in the non-dominant hand. No association was found between these scores and the duration of the disease (Table IV).

Table II. *Prevalence of subjectively reported symptoms related to disease duration*

	2–4 years $n=50$	4–6 years $n=52$	6–8 years $n=49$	≥8 years $n=49$	*p*-value of test of difference between 4 disease duration groups†	*p*-value of test of difference between groups <8 and ≥8 years‡
Age, years, mean (SD)	58.3 (11.0)	57.9 (11.3)	62.4 (9.9)	60.4 (10.3)	0.14	0.61
Any symptom, %	94	100	92	92	0.86	0.59
Pain, %	93	92	87	87	0.20	0.42
Stiffness, %	82	75	76	60	0.03*	0.02*
Muscle weakness, %	73	56	69	80	0.26	0.07
Paraesthesia, %	42	25	38	24	0.21	0.21
Limited fist, %	24	25	24	33	0.37	0.25
Limited pinch grip, %	0	0	4	4	0.06	0.22
Joint deviation, %	4	15	13	13	0.27	0.71
Aesthetics, %	11	12	11	11	0.98	0.98
Other, %	2	6	11	4	0.45	0.64
NRS pain, mean (SD)						
Dominant hand	2.6 (2.3)	2.4 (2.3)	2.4 (2.6)	2.7 (2.8)	0.89	0.50
Non-dominant hand	2.1 (2.2)	1.9 (1.9)	1.9 (2.2)	2.4 (2.5)	0.61	0.21

*$p<0.05$.
†Differences in prevalence between 4 disease duration groups were investigated with an χ² test for trend (dichotomous variables) or a one-way analysis of variance (NRS pain).
‡In a secondary analysis, differences between patients with a disease duration of <8 years and ≥8 years were investigated with a χ² test (dichotomous variables) or a one-way analysis of variance (NRS pain).
SD: standard deviation; NRS: Numerical Rating Scale.

Table III. *Prevalence of objectively assessed impairments, related to disease duration*

Impairment	2–4 years $n=50$	4–6 years $n=52$	6–8 years $n=49$	≥8 years $n=49$	p-value of test of difference between 4 disease duration groups†	p-value of test of difference between groups <8 and ≥8 years‡
≥1 impairment						
dominant hand, %	70	65	67	76	0.53	0.29
non-dominant hand, %	66	60	61	80	0.16	0.03*
Limited pROM wrist						
dominant hand, %	28	15	20	35	0.36	0.06
non-dominant hand, %	20	15	18	31	0.18	0.06
Limited pROM finger joints						
dominant hand, %	28	21	29	49	0.02*	0.002*
non-dominant hand, %	26	29	27	43	0.10	0.04*
Stenosing tenosynovitis ≥ gr 2						
dominant hand, %	24	19	22	20	0.78	0.83
non-dominant hand, %	26	17	18	20	0.54	0.99
Involvement CMC-1 joint						
dominant hand, %	18	17	27	31	0.08	0.15
non-dominant hand, %	16	17	22	31	0.06	0.07
Z-deformity thumb						
dominant hand, %	2	15	12	12	0.15	0.68
non-dominant hand, %	0	10	10	16	0.002*	0.006*
Tendinitis of ext. tendons						
dominant hand, %	2	2	2	12	0.02*	0.003*
non-dominant hand, %	2	0	4	4	0.30	0.41
Signs of CTS						
dominant hand, %	6	10	4	2	0.23	0.22
non-dominant hand, %	8	6	6	6	0.74	0.90

*$p<0.05$.
†Differences in prevalence between 4 disease duration groups were investigated with a χ^2 test for trend.
‡In a secondary analysis, differences between patients with a disease duration of <8 years and ≥8 years were investigated with an χ^2 test.
pROM: passive range of motion; gr: grade; CMC-1: first carpometacarpophalangeal joint; ext: extensor; CTS: carpal tunnel syndrome.

DISCUSSION

Symptoms

Almost all the patients had at least one hand and wrist symptom. The prevalence of pain was high, although the pain was not very intense and had no association with disease duration. There was a high prevalence of reported stiffness of the hand, but with a significantly lower prevalence in sub-groups with a longer disease duration. Many patients reported muscle weakness, but this had no association with disease duration. The prevalence

of symptoms was higher than expected, based on our clinical experience, also in the group with the shortest disease duration. This discrepancy might be explained by the fact that patients reported that normally they do not complain about their hand and wrist problems because they adapt to the situation, and because they do not expect any effective treatment to be available.

Impairments

A high prevalence of hand and wrist impairments was found. The prevalence of limited pROM of any finger joint in the

Table IV. *Prevalence of activity limitations, related to disease duration*

Disabilities	2–4 years $n=50$	4–6 years $n=52$	6–8 years $n=49$	≥8 years $n=49$	p-value of test of difference between 4 disease duration groups†	p-value of test of difference between groups <8 and ≥8 years‡
DASH, median (IQR)	21.7 (10.4–37.7)	26.7 (12.5–41.3)	25.0 (7.5–45.4)	26.7 (9.1–48.3)	0.94	0.65
NRS, mean (SD)						
dominant hand	3.1 (2.4)	2.8 (2.2)	2.8 (2.5)	3.1 (2.9)	0.83	0.57
non-dominant hand	2.3 (2.2)	2.7 (2.7)	2.5 (2.3)	2.9 (2.7)	0.66	0.37

*$p<0.05$.
Prevalences were compared between all different disease duration groups.
†Analysis of variance with one-sided testing was applied to evaluate significance.
‡In a secondary analysis, differences between patients with a disease duration of <8 years and ≥8 years were investigated with a one-way analysis of variance.
DASH: Disabilities of the Arm Shoulder and Hand questionnaire; IQR: inter-quartile range; SD: standard deviation; NRS: Numerical Rating Scale for patient-reported hand activity limitations.

dominant and non-dominant hand, and of Z-deformity of the non-dominant thumb was significantly higher in the sub-groups with a longer disease duration. In our opinion, it is important to diagnose a Z-deformity in an early stage in order to try to prevent or retard the development of irreversible joint contractures (which may lead to impaired grip function via splinting), and to provide information on use of the hands.

A high prevalence of stenosing tenosynovitis was found in all categories of disease duration. Awareness of this can be valuable in clinical practice because, in our experience, untreated stenosing tenosynovitis may eventually lead to MCP subluxation, caused by muscular imbalance, with dominating and shortening of intrinsic hand muscles. Treatment, via exercises, massage and information on use of the hands, in combination with splinting and once-only injection therapy, is most successful when initiated in grade 1 and in the early phase of grade 2 tenosynovitis; surgical intervention is needed for longer lasting grade 2, and also grade 3 tenosynovitis.

We found a low prevalence of tendinitis of the extensor tendons, but in the dominant hand the prevalence was significantly higher in the sub-groups with a longer disease duration. Since longstanding (>6 months) tendinitis increases the risk of extensor tendon rupture (23, 24), timely recognition is important so that splinting treatment can be initiated.

Activity limitations

The median standardized DASH score for all included patients was 26.7; 30% of the patients had an abnormal DASH score. When comparing the DASH scores of our participants with those of patients after hand injuries, our findings can be interpreted as "severely functionally impaired" (21). No association was found with disease duration: high scores were already observed in an early stage of the disease. The high DASH scores seem to be in contrast with the NRS score for the use of hands, which was 2.99 in the dominant hand and 2.59 in the non-dominant hand. It is difficult to understand this discrepancy, so there is a need for further study to determine the precise nature of the limitations.

In general, we had not expected to find such high prevalences of hand symptoms and impairments. On the other hand, we had expected to find an association with disease duration for most symptoms and impairments, and we were surprised that we could not determine a clear transition point after which there is a higher prevalence of symptoms and impairments: symptoms, impairments and activity limitations were already found in the sub-group with the shortest disease duration (2–4 years).

Although there was a high percentage of non-participants, we believe that our study population is representative for the total group of RA patients in our EAC cohort. The mean age of the participants was higher than the mean age of the total cohort, and they had a trend towards a slightly higher DAS28 score. This might have led to an over-estimation of the prevalence of symptoms and impairments in our population. However, we estimate that this will only be a minor over-estimation, because of the equal distribution in both cohorts of radiographically determined joint damage and the findings of the HAQ with its category score HAQ-grip at the time of our study.

In conclusion, in our representative sample of 200 RA patients there was a high prevalence of hand and wrist symptoms and impairments, despite low disease activity. Only some symptoms and impairments were associated with disease duration (subjectively experienced less stiffness of the hand, and more objectively assessed limited pROM of the finger joints, more Z-deformity of the thumb, and more tendinitis of the extensor tendons), but most were already highly prevalent in the early stages of the disease (limited pROM of the wrist, stenosing tenosynovitis of the finger flexors, and involvement of the CMC-1 joint). Although the observed impairments might not be very severe, they did seem to lead to activity limitations in 30% of the patients. Based on our findings, together with the tendency of patients to under-report their hand problems, we recommend that physicians specifically ask about symptoms and screen for hand and wrist impairments, starting no later than 2 years after the diagnosis of RA. Via such a screening, timely and adequate non-pharmacological treatment can be provided in order to minimize further loss of hand function and increased activity limitations in patients with RA.

REFERENCES

1. Fleming A, Benn R, Corbett M, Wood P. Early rheumatoid disease II. Patterns of joint involvement. Ann Rheum 1976; 35: 361–364.
2. Schumacher H, Habre W, Meador R, Hsia E. Predictive factors in early arthritis: long-term follow-up. Semin Arthritis Rheum 2004; 33: 264–272.
3. Fleming A, Crown J, Corbett M. Early rheumatoid disease: onset. Ann Rheum Dis 1976; 35: 357–360.
4. Boutry N, Larde A, Lapegue F, Solau-Gervais E, Flipo R, Cotten A. Magnetic Resonance Imaging appearance of the hands and feet in patients with early Rheumatoid Arthritis. J Rheumatol 2003; 30: 671–679.
5. Flatt AE. The care of the arthritic hand. 5th edn. St Louis: Mosby; 1995.
6. Kooij van der SM, Goekoop-Ruiterman YP, Vries de-Bouwstra JK, Peeters AJ, Krugten van MV, Mreedveld FC, et al. Probability of continued low disease activity in patients with recent onset rheumatoid arthritis treated according to the disease activity score. Ann Rheum Dis 2008; 67: 266–269.
7. Arnett C, Edworthy S, Bloch D, McShane D, Fries J, Cooper N, et al. The American Rheumatism Association 1987 revised criteria for the classification of rheumatoid arthritis. Arthritis Rheum 1988; 31: 315–324.
8. Prevoo ML, Hof van't MA, Kuper HH, Leeuwen van MA, Putten van der LB, Riel van PL. Modified disease activity scores that include twenty-eight-joint counts. Development and validation in a prospective longitudinal study of patients with rheumatoid arthritis. Arthritis Rheum 1995; 38: 44–48.
9. Heijde van der DM, Leeuwen van MA, Riel van PL, Koster AM, Hof van't MA, Rijswijk MH, et al. Biannual radiograhic assessments of hands and feet in a three-year prospective follow-up of patients with early rheumatoid arthritis. Arthritis Rheum 2001; 44: 1719–1721.
10. Siegert CE, Vleming LJ, VanderBroucke JP, Cats A. Measurement of disability in Dutch rheumatoid arthritis patients. Clin Reumatol 1984; 3: 305–309.
11. Bijlsma JW, Oude Heuvel CH, Zaalberg A. Development and validation of the Dutch questionnaire capacities of daily life (VDF) for patients with rheumatoid arthritis. J Rehab Science 1990; 3: 71–74.
12. Vliet Vlieland T, Wijk van der T, Jolie I, Zwinderman A, Hazes J. Determinants of hand function in patients with rheumatoid arthritis.

J Rheumatol 1996; 23: 835–840.

13. Heck CV. Joint motion: method of measuring and recording. 13th edn. Edinburgh: Churchill Livingstone; 1988.

14. Cambridge-Keeling C. Range-of-motion measurement of the hand. In: Hunter J, editor. Rehabilitation of the hand: surgery and therapy. St Louis: Mosby; 1995, p. 93–107.

15. Goossens P, Heemskerk B, Tongeren van J, Zwinderman A, Vliet Vlieland T, Huizinga T. Reliability and sensitivity to change of various measures of hand function in relation to treatment of synovitis of the metacarpophalangeal joint in rheumatoid arthritis. Rheumatology 2000; 39: 909–913.

16. Peter W, Steultjens MPM, Mesman T, Dekker J, Hoeksma AF. Inter-observer reliability of the Amsterdam Severity Scale in Stenosing Tenosynovitis (ASSiST). J Hand Ther 2009; 22: 355–360.

17. American Society for Surgery of the Hand. The hand: examination and diagnosis. 3rd edn. New York: Churchill Livingstone; 1990.

18. Bot SDM, Terwee CB, Windt van der DAWM, Bouter LM, Dekker J, Vet de HCW. Clinimetric evaluation of shoulder disability questionnaires: a systematic review of the literature. Ann Rheum Dis 2004; 63: 335–341.

19. McDermid JC, Tottenham V. Responsiveness of the Disability of the Arm, Shoulder and Hand (DASH) and Patient-Rated Wrist/Hand Evaluation (PRWHE) in evaluating change after hand therapy. J Hand Ther 2004; 17: 18–23.

20. Raven EEJ, Haverkamp D, Sierevelt IN, Montfoort van DO, Pöll RG, Blankevoort L, et al. Construct validity and reliability of the Disability of Arm, Shoulder and Hand questionnaire for upper extremity complaints in rheumatoid arthritis. J Rheumatol 2008; 35: 2334–2338.

21. Poerbodipoero SJ, Steultjens MPM, Beek van der AJ, Dekker J. Pain, disability in daily activities and work participation in patients with traumatic hand injury. Br J Hand Ther 2007; 12: 40–47.

22. Hunsaker FG, Cioffi DA, Amadia FC, Wright JG, Caughlin B. The American Academy of Orthopaedic Surgeons Outcomes Instruments; normative values from the general population. J Bone Joint Surg Am 2002; 84-A: 208–215.

23. Ryu J, Saito S, Honda T, Yamamoto K. Risk factors and prophylactic tenosynovectomy for extensor tendon ruptures in the rheumatoid hand. Br J Hand Surg 1998; 23B: 658–661.

24. Brown FE, Brown ML. Long-term results after tenosynovectomy to treat the rheumatoid hand. Am J Hand Surg 1988; 13A: 704–708.