Inflammation as a target for treatment in hand osteoarthritis

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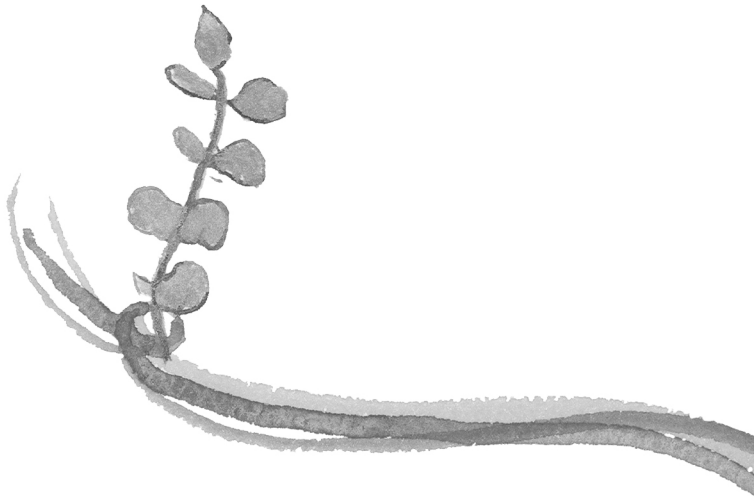
CHAPTER 12

Validity, reliability, responsiveness and feasibility of four hand mobility measures in hand osteoarthritis



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ABSTRACT

Objectives. To investigate metric properties of four hand mobility tests in hand OA patients, using the OMERACT filter.

Methods. Trained assessors examined the Hand Mobility in Scleroderma test (HAMIS), fingertip-to-palm distance (FPD), modified Kapandji index (MKI) and number of hand joints with limited mobility in participants from two cohorts [Genetics Arthrosis and Progression (n=207), Hand OSTeoArthritis in Secondary care (n=174)]. Validity was appraised by assessment of correlations with other outcome measures, and ability to measure thumb vs finger mobility specifically, using cumulative probability plots. Proportion of participants changing in hand mobility based on the smallest detectable difference was calculated for responsiveness. Intraclass correlation coefficients (ICCs) for intra- and interobserver reliability, and feasibility (time to perform tests) were studied in a random sample (n=20).

Results. Participants displayed large variation in mobility scores. Strongest correlations were observed with structural damage (r_s=0.43-0.52) and bony swelling (r_s=0.46-0.58); correlation patterns were similar among tests. HAMIS, FPD and MKI could all measure finger mobility specifically, but only HAMIS measured thumb mobility particularly. Interobserver reliability was best for HAMIS, ICC 0.90 (95% CI: 0.76, 0.96); intraobserver reliability was excellent for all (ICCs 0.94-0.97). In 2 years, little change was observed; HAMIS was the most sensitive-to-change (smallest detectable difference 3.7% of maximum score). The mean performance time ranged from 0.7 (SD 0.5, for FPD) to 5.7 (SD 1.3, for HAMIS) min.

Conclusions. HAMIS, FPD, MKI and number of joints with limited mobility are all valid, reliable and feasible measures to assess hand mobility in hand OA, although HAMIS had slightly more favourable properties. Studies assessing sensitivity-to-change in clinical trial setting are warranted.

INTRODUCTION

Hand OA leads to pain, restrictions in daily activity and decreased quality of life.[1] Many patients suffer from decreased range of motion of the fingers and difficulty in making a fist.[2] It was acknowledged by hand OA experts that so-called 'hand mobility' is important for patients, and therefore it was proposed by the OMERACT hand OA working group as a core domain to be assessed in observational studies and trials.[3,4] However, hand mobility is seldom investigated in hand OA studies due to a lack of disease-specific instruments, and it may be perceived as a lengthy examination. Development of a disease-specific instrument for assessing hand mobility was therefore listed on the OMERACT research agenda.[3]

Several instruments for measuring hand mobility were encountered in the literature, including the Hand Mobility in Scleroderma test (HAMIS),[5,6] fingertip-to-palm distance during maximal finger flexion (FPD),[7] and modified Kapandji index (MKI).[8,9] These performance-based tests were all developed and validated in other disease areas, i.e. to assess hand mobility in SSc patients (HAMIS, FPD) or as a tool for assessing the effect of surgical interventions of the hand and wrist (MKI). Previous studies have shown that the HAMIS and FPD are valid and reliable in SSc,[5-7] and the latter has been recommended as an outcome measure in SSc clinical trials.[10] Good reliability and validity of the MKI and HAMIS were demonstrated in RA patients.[8,9,11,12] Poor-to-moderate reliability of the thumb opposition subscore of the MKI was reported in a population with self-reported hand problems.[13]

With respect to hand OA, only one study compared several self-reported and performance-based tests of function, including the HAMIS as a performance-based test.[14] However, the validity and reliability of the FPD and MKI has not been investigated in hand OA before, nor were the tests compared with one another. It is also unclear whether these tests perform differently in patients with predominantly IP compared with CMC OA, although it is not unlikely that IP OA patients experience most limitations in movements of the fingers, whereas the CMC OA patients suffer limited thumb mobility.

Our aim was to investigate the metric properties of these three hand mobility tests, also in comparison with the assessment of hand mobility by a trained research nurse, in patients with symptomatic hand OA, using the OMERACT filter: truth, discrimination and feasibility.[15]

METHODS

Study design and patient population

Analyses were performed in two cohorts. Cross-sectional analyses investigating truth were performed in the Genetics ARthrosis and Progression (GARP) study, consisting of 192 siblings with symptomatic OA at multiple sites in the hands or in two or more of the following sites: hand, knee, hip or spine. Participants with hand OA according to ACR criteria, who completed the 6-year follow-up visit were included in this study (n=207).[16] Discrimination and feasibility were investigated in the Hand OSTeoArthritis in Secondary care (HOSTAS) study, an ongoing observational cohort including consecutive patients from Leiden University Medical Center

outpatient clinic with primary hand OA diagnosed by their treating rheumatologist. Participants fulfilling hand OA ACR criteria who underwent hand mobility evaluation at two visits (baseline, 2-year follow-up) were included in the analysis (n=174). Both studies were approved by the medical ethics committee of the Leiden University Medical Center (Protocol numbers P76/98-16 and P09.004). All participants gave written informed consent. Details on recruitment and selection of both cohorts have been published elsewhere.[17,18]

Hand mobility measures

Hand mobility tests were performed during standardized physical examination by a trained researcher. The HAMIS consists of nine tasks, assessing finger, thumb and wrist mobility [each scored 0 (no impairment) to 3 (cannot perform), maximum score 27 per hand].[5,6] The FPD was obtained by measuring the distance (millimetres) of the second to fifth finger between fingertip and distal palmar crease while making a full fist, and summing the distances (higher scores indicate more limitation).[7] For the MKI, opposition of the thumb and flexion and extension of the fingers was assessed using anatomic landmarks of the hand as references, obtaining a total score by summing the scores of three items (range 0-50 per hand, lower scores indicating more limitation).[8,9] Total scores for each test were calculated as the mean of two hands. Additionally, the HAMIS and MKI were split in separate components assessing finger [HAMIS: finger flexion, extension and abduction (range 0-9); MKI: flexion and extension of second to fifth finger (range 0-40)] and thumb mobility [HAMIS: thumb abduction and pincer grip (range 0-6); MKI: thumb opposition (range 0-10)] specifically. Component scores were calculated by summing relevant subscores. The FPD was not split, since it solely assesses finger flexion. Finally, hand mobility was also assessed during physical examination by trained research nurses, who evaluated the presence of limited mobility while making a fist in the distal and proximal IP joints, IP-1, first MCP joint and CMC-1. The number of joints with limited mobility was summed to reach a total score (range 0-22). A detailed description of the hand mobility measures can be found in the supplementary data.

Furthermore, the number of hand joints with bony swellings (0-30) and deformities (0-22) were measured. Grip strength (kilogram) was measured using a hydraulic hand dynamometer (Saehan Corporation, Masan, South-Korea) and the average of two hands was calculated.

Questionnaires

Patients indicated location of painful or stiff joints on a hand diagram (range 0-30). Subsequently, patients were assigned to one of three groups for pre-specified subgroup analyses: (i) CMC symptoms only; (ii) IP symptoms only; or (iii) symptoms at both sites. Self-reported hand pain and function were assessed with the Australian/Canadian Osteoarthritis Hand Index on a five-point Likert scale (higher scores being worse).[19]

Imaging

On hand radiographs, osteophytes and joint space narrowing were graded 0-3 in DIP, PIP and CMC-1 joints, and 0-1 in IP-1 and scaphotrapezotrapezoidal joints, using the Osteoarthritis Research Society International atlas, and summed to obtain a total OP or joint space narrowing

score (range 0-58).[20] Presence of erosive joints was assessed in DIPs and PIPs according to the Verbruggen-Veys scoring method, defined as a joint in the erosive (E) or remodelling (R) phase.[21] Intra-reader reliability for radiographic scoring was published previously and was good in both studies.[22,23]

MRI of the right DIP and PIP joints was performed in HOSTAS at baseline. Coronal and axial T1-weighted post-contrast images were acquired on an ONI-MSK-Extreme 1.5T extremity MRI unit (GE, WI, USA). Synovitis was graded 0-3 using a modified version of the Oslo hand OA MRI scoring system.[24] Published intra-reader reliability was good.[23] Only MRIs that were performed within 3 weeks of physical examination were used for analyses.

Use of the OMERACT filter to evaluate hand mobility tests

Truth

Correlations of each hand mobility test with other outcome measures were assessed using Spearman correlation coefficients (r_s), as data were not normally distributed. Correlation coefficients of ≤0.30, 0.31-0.50, 0.51-0.70 and >0.71 were considered very weak, weak, moderate and strong, respectively. It was hypothesized that the tests measure at large the same concept, and that the mutual correlation would therefore be at least moderate. A convergent correlation was hypothesized between the tests and structural damage, self-reported hand function and joint activity (measured as synovitis on MRI). Weaker correlations were expected with grip strength and self-reported pain.

Multivariable linear regression analysis was performed to investigate whether hand mobility tests are capable of measuring a unique domain that is not measured by (a combination of) other outcome measures. The assessed domains were structural damage, physical function, grip strength, pain and joint activity.[3] Explained variance was assessed using the coefficient of determination (R^2), which shows how much variation in the dependent variable (hand mobility) is explained by the model. A lower R^2 was interpreted as a lower explained variance, indicating that hand mobility was for a larger part a unique domain. The final model, with the highest R^2, was selected using a manual forward selection approach. Improvement of subsequent models was assessed using the *F*-statistic with $p<0.05$ and a ≥10% change in R^2 defined *a priori* as a meaningful improvement in model fit.

To investigate whether the finger and thumb components of the HAMIS, FPD and MKI measure mobility specifically at those sites, we compared total scores as well as finger- and thumb-subscores amongst patients with CMC or IP symptoms only, and those with symptoms at both sites using cumulative probability plots. In these plots, individual hand mobility (sub)scores of each participant in each subgroup are plotted in a cumulative order (from the lowest value starting at zero, to the highest value ending at 1060%), calculating the cumulative probability per subgroup.

Discrimination

To evaluate intra- and interobserver reliability, a random sample of 20 patients undergoing pre-planned visits for the HOSTAS study were rescored with each method by the same observer (at a later time the same day) and by a different observer, both blinded to the scores of the first assessment. Intraclass correlation coefficients were calculated (average measure, mixed-effect models, absolute agreement), and additionally Bland-Altman plots were drawn.[25]

Responsiveness was assessed using baseline and 2-year follow-up data from HOSTAS. The smallest detectable difference (SDD) of each test was calculated using interobserver reliability data as $\pm 1.96^{*}(SD_{\text{delta status score}} /\sqrt{k})$, with k=2.[25] The proportion of participants whose hand mobility improved, remained stable or worsened was calculated using the SDD as the cut-off.

Feasibility
To investigate feasibility, information was collected in the same sample of 20 on the time it took to complete the tests, and the appliances needed.

Data were analysed using SPSS V23 (Armonk, NY, USA).

RESULTS

Population description

Characteristics of the participants of both cohorts are presented in table 1. Participants displayed large variation in scores, although hand mobility appeared not greatly affected in most patients. Scores were slightly worse in HOSTAS compared to GARP.

Truth

Correlation with other outcome measures
As shown in table 2, analyses in GARP showed that the hand mobility tests correlated well among one another (r_s=0.53-0.73). Correlation coefficients of hand mobility tests with other outcomes were, however, moderate at best. Correlations did not increase when adopting the hand as the unit of analysis (supplementary table 3). The strength of correlations with other outcomes was similar for all tests (see table 2). Structural damage, measured with the Osteoarthritis Research Society International osteophyte score and number of joints with bony swellings, demonstrated the best correlation with the hand mobility tests (r_s= 0.43-0.52 and r_s= 0.46-0.58). Self-reported hand function was weakly correlated with hand mobility (r_s=0.25-0.43), as were grip strength (r_s=0.08-0.33) and pain (r_s=0.25-0.34). Replication of these correlations in HOSTAS produced similar results (see supplementary table 4). Synovitis on MRI, as a measure of joint activity, was only available in HOSTAS, and showed weak to moderate correlations with hand mobility (r_s=0.33-0.55).

Hand mobility as a unique domain
In GARP, the multivariable regression model explained 38-46% of the variance, depending on the mobility test investigated (see supplementary table 5). This means, that the tests measure in part something that is also assessed by (a combination of) other domains, but partly also a unique domain. The domain partially explaining hand mobility scores was structural damage, and a trend for self-reported function was seen, although the latter did not contribute to number of joints with limited mobility. We repeated the regression analysis in participants of the HOSTAS cohort in whom synovitis on MRI (as a measure of joint activity) was available for analysis (n=67). These

analyses resulted in an explained variability of 29-52% with structural damage, grip strength and to a lesser extent self-reported function (HAMIS and MKI) or joint activity (FPD and number of joints with limited mobility) as the contributing domains.

Table 1. Characteristics of included participants of the GARP and HOSTAS study.

	GARP cohort (N=207)	HOSTAS study (N=174)
Female, n(%)	178 (86.0)	144 (82.8)
Age, years	64.2 (59.5-69.1)	60.1 (54.6-65.9)
BMI, kg/m^2	27.0 (24.2-31.3)	26.9 (24.7-29.9)
Dominant hand right, n(%)	157 (75.8)	131 (75.3)
Number of self-reported painful joints, 0-30	8 (3-14)	10 (6-14)
AUSCAN		
Pain subscale, 0-20	8 (5-11)	10 (6.8-12)
Stiffness subscale, 0-4	2 (1-2)	2 (1-2)
Function subscale, 0-36	16 (9-22)	15 (9-21)
Number of joints with bony swelling, 0-30	14 (10-18)	12 (8-15)
Number of joints with deformity, 0-22	1 (0-3)	4 (2-6)
Grip strength, kg	19.5 (14.3-25.3)	23.3 (18.2-28.4)
HAMIS, 0-54	3.5 (2-5.5)	4.5 (3-7)
Finger-palm distance, mm	7 (0-43)	34.5 (7.5-83.8)
Modified Kapandji Index, 0-50	48 (45-49.5)	43 (39-45.6)
Number of joints with limited mobility, 0-22	2 (0-6)	5 (2-10)
OARSI osteophyte score, 0-58	10 (6-16)	11 (5-20)
OARSI JSN score, 0-58	18 (13-24)	8 (3-18.3)
Number of erosive joints, 0-30	0 (0-1)	0 (0-2)
Synovitis score MRI, 0-24[a]	-	5 (2-7)

Median (IQR) unless indicated otherwise. [a]MRI data of the DIPs and PIPs of the right hand performed within 3 weeks of physical examination were available for 67 participants from the HOSTAS study. AUSCAN, Australian/Canadian osteoarthritis hand index; GARP, Genetics ARthrosis and Progression; HAMIS, hand mobility in scleroderma; HOSTAS, Hand OSTeoArthritis in Secondary care; JSN, joint space narrowing; OARSI, Osteoarthritis Research Society International.

Finger and thumb mobility

In GARP, differences in hand mobility scores among the HAMIS, FPD and MKI were investigated across subgroups of participants with CMC symptoms only (n=7), IP symptoms only (n=74) and symptoms at both sites (n=126). Cumulative probability plots show that all (subscores of) tests measuring finger mobility specifically, could discriminate between participants with finger and combined OA vs CMC OA (figure 1A). However, although the HAMIS thumb subscore appeared to be able to discriminate between thumb vs finger complaints, the MKI thumb subscore was not (figure 1B). The suggestion that the thumb subscores of HAMIS and MKI do not measure the same concept, was confirmed by a low correlation between these scores (r_s=-0.27), whereas correlations among the finger tests were moderate to good (r_s=0.68-0.82).

Table 2. Correlations of hand mobility tests with other outcome measures in the GARP study.

	HAMIS	Finger-palm distance	MKI	Number of joints with limited mobility
HAMIS		0.53*	-0.63*	0.66*
Finger-palm distance	0.53*		-0.73*	0.53*
MKI	-0.63*	-0.73*		-0.65*
Number of joints with limited mobility	0.66*	0.53*	-0.65*	
Structural damage				
Total OARSI osteophyte score	0.47*	0.43*	-0.43*	0.52*
Number of bony swellings	0.46*	0.47*	-0.47*	0.58*
Hand function				
AUSCAN function	0.43*	0.25*	-0.32*	0.28*
Hand strength				
Grip strength	-0.33*	-0.16*	0.22*	-0.08
Hand pain				
AUSCAN pain	0.34*	0.25*	-0.28*	0.25*
Joint activity				
Synovitis on MRI[a]	0.47*	0.52*	-0.33*	0.55*

[a]Data from HOSTAS, correlations between MRI of the DIP and PIP joints of the right hand and hand mobility scores of that hand are shown. *Statistically significant ($p<0.05$). AUSCAN, Australian/Canadian osteoarthritis hand index; GARP, Genetics ARthrosis and Progression; HAMIS, hand mobility in scleroderma; HOSTAS, Hand OSTeoArthritis in Secondary care; MKI, modified Kapandji index; OARSI, Osteoarthritis Research Society International.

Discrimination

Reliability

As shown in table 3 the intraobserver reliability was >0.94 for all tests , and interobserver reliability >0.78. Bland-Altman plots (supplementary figures S1 and S2) showed that differences between observers could be quite large for FPD and number of joints with limited mobility. However, no clear systematic bias could be detected, other than a possible trend towards a slightly improved HAMIS and MKI score during the second observation by the same rater, which may indicate a learning curve for patients and/or observers.

The SDD of HAMIS was the lowest [2.0 (3.7% of maximum possible score)], followed by MKI [6.1 (12.1%)], number of joints with limited mobility [7.1 (23.7%)] and FPD [42.5 mm (22.3% of maximum observed score)].

Responsiveness

Change scores after 2 years of follow-up of 174 participants of HOSTAS are presented in table 4. A small increase in radiographic damage was observed, as well as an increase in number of joints with bony swelling. However, most other clinical parameters did not change over time. On average, the four mobility tests also remained stable over time. Using the SDDs as a cut-off, the number of participants with a 'true' change over time was determined, revealing a similar percentage of participants worsening over time according to HAMIS, MKI and FPD (7.5, 8.1 and 8.2%, respectively) and a slightly higher percentage worsening according to the number of joints with limited mobility (14.0%). Using the SDD as a cut-off, 69.0% (HAMIS) to 81.5% (MKI) of participants remained stable over time, and 10.4% (MKI) to 23.5% (HAMIS) improved.

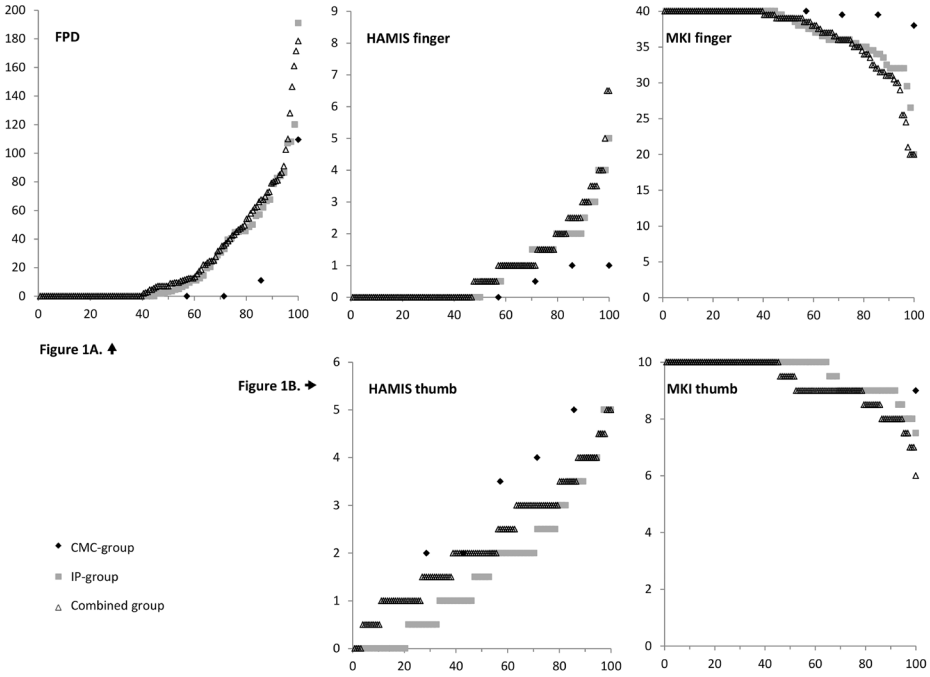

Figure 1. Cumulative probability plots of hand mobility tests in subgroups of hand OA patients.

A. Tests assessing finger mobility. **B**. Tests assessing thumb mobility. Cumulative probability plots, on which scores of each individual are plotted in a cumulative order, comparing hand mobility scores between subgroups with complaints at CMC or IP joints only, and those with complaints at both sites.

Table 3. Reliability and time to perform the hand mobility test in 20 patients of the HOSTAS study.

	Intraobserver reliability[a] ICC (95% CI)	**Interobserver reliability**[b] ICC (95% CI)	**Time in minutes** mean (SD)
HAMIS	0.94 (0.84-0.97)	0.90 (0.76-0.96)	5.7 (1.3)
Finger-palm distance	0.95 (0.87-0.98)	0.79 (0.54-0.91)	0.7 (0.5)
Modified Kapandji Index	0.97 (0.93-0.99)	0.78 (0.52-0.91)	3.1 (0.9)
Number of joints with limited mobility	0.97 (0.93-0.99)	0.81 (0.52-0.93)	1.1 (0.8)

[a]Average of n=2 observers for number of joints with limited mobility, and n=1 observer for the other tests. [b]Calculated for n=2 observers for number of joints with limited mobility, and n=5 observers for the other tests. HAMIS, hand mobility in scleroderma; HOSTAS, Hand OSTeoArthritis in Secondary care; ICC, intraclass correlation coefficient; OARSI, Osteoarthritis Research Society International.

Table 4. Change scores of participants in the HOSTAS study (n=174) after 2 years of follow-up.

	Change score mean difference, 95% CI
Number of self-reported painful joints, 0-30	0.44 (-0.57 to 1.45)
AUSCAN	
Pain subscale, 0-20	-0.60 (-1.14 to -0.06)
Stiffness subscale, 0-4	-0.01 (-0.14 to 0.13)
Function subscale, 0-36	-0.06 (-0.88 to 0.76)
Number of joints with bony swelling, 0-30	1.06 (0.42 to 1.69)
Number of joints with deformity, 0-22	-0.87 (-1.32 to -0.42)
Grip strength, kg	0.37 (-0.57 to 1.30)
HAMIS, 0-54	-0.79 (1.11 to -0.47)
Finger-palm distance, mm	-2.61 (-8.57 to 3.34)
Modified Kapandji index, 0-50	0.79 (-0.03 to 1.62)
Number of joints with limited mobility, 0-22	0.13 (-0.79 to 1.05)
OARSI osteophyte score, 0-58[a]	1.71 (1.28 to 2.13)
OARSI JSN score, 0-58[a]	1.27 (0.74 to 1.79)
Number of erosive joints, 0-30[a]	0.33 (0.18 to 0.47)

[a]Radiographs at two time points available from 79 participants. AUSCAN, Australian/Canadian osteoarthritis hand index; HAMIS, hand mobility in scleroderma; HOSTAS, Hand OSTeoArthritis in Secondary care; JSN, joint space narrowing; OARSI, Osteoarthritis Research Society International.

Feasibility

The time to perform each hand mobility test is shown in table 3. The FPD and number of joints with limited mobility were performed the fastest, that is, in 0.7 and 1.1 min, respectively, with minimal appliances needed (a ruler for the first, and none for the latter). Performance of the MKI and HAMIS, consisting of five and nine items per hand, respectively, took longer, although the time per task was similar for these two tests (both mean 0.6 min). The appliances needed to perform HAMIS was the most extensive (n=6, including five custom-made cylinders of different diameters to ensure consistency).

DISCUSSION

In this study, we examined the metric properties of four hand mobility tests, using the OMERACT filter. All tests showed good reliability and feasibility, similar convergent correlations with other outcome measures and appeared to measure in part a unique domain not explained by (a combination of) other outcome domains. The latter endorses the usefulness of measuring hand mobility as a separate outcome, as proposed by the OMERACT hand OA working group.[3] In general, the tests all seem to measure approximately the same concept. However, although HAMIS, FPD and MKI were all able to specifically measure finger mobility, only HAMIS could distinguish between patients with and without reduced thumb

mobility. Since thumb involvement is prevalent in hand OA, this is an important strength of the HAMIS.[26] While the MKI also includes a subscore for the thumb, it did not distinguish CMC from IP OA patients. Notably, MKI and HAMIS assess different thumb movements: HAMIS measures thumb abduction and pincer grip, whereas MKI measures thumb opposition. It could be hypothesized that the first two movements are more impaired in thumb base OA than the latter, explaining the observed difference between the tests, although data supporting this hypothesis is scarce.

We observed only a small proportion of patients with a deterioration in hand mobility over 2 years, despite, for example, radiographic progression, and some even showed improved mobility. Based on the calculated SDD, HAMIS appeared the most responsive. The low observed rate of progression in hand mobility could mean that the tests are not sensitive enough to measure change over time, which would make the tests less useful for longitudinal studies. Another possibility is that changes in hand mobility do not occur within a 2-year timeframe, which would suggest that this outcome is not useful to assess in (usually short-term) clinical trials. It may also reflect that hand OA is a heterogeneous disease, with some progressing, but others experiencing a more stable disease course. The lack of a gold standard for measuring hand mobility makes it difficult to distinguish these possible explanations. Moreover, our analyses were performed in a prospective cohort study, in which no intervention was administered to the patients besides usual care. Therefore, regression to the mean may explain why some patients showed an improvement in hand mobility, since patients' inclusion usually occurred at time of diagnosis at the rheumatologist, causing patients to be included often at the peak of their complaints. Other explanations for the relatively high number of patients showing improved hand mobility may be the disease course under usual care (e.g. less joint activity over time, or adjustment of ligaments and other joint structures to structural changes). Unlike radiographic damage, hand mobility may not only deteriorate over time. Future studies assessing responsiveness of these tests, including an assessment of sensitivity-to-change, are warranted and should ideally be performed in clinical trial settings.[27]

The assessment of hand joint mobility by a trained research nurse, as investigated in this study, is not a previously published test, but is based on routine clinical physical examination. Our data suggest, that this assessment is not superior to the other three methods regarding any of the assessed metric properties, although it did also not perform substantially worse. Our data do not provide a reason to advocate the use of this assessment of hand mobility over one of the other three tests in research settings. However, as this test is less easy to standardise, we prefer the other three published tests.

To our knowledge, this is the first study comparing different hand mobility tests in hand OA patients. One previous study compared several self-reported and performance-based hand function tests in hand OA patients, including the finger extension, and thumb and finger abduction items of the HAMIS as one of the performance-based tests.[14] That study reported mild joint limitations, as in our study, but found a slightly higher correlation with self-reported function ($r \approx 0.50$), although this discrepancy may be explained by the restriction of their analyses to thumb and finger movements. Bijsterbosch *et al* compared the FPD and HAMIS in patients with and without erosive hand OA, reporting more limitations in patients with erosive disease.[28]

Strengths of this study are the performance of multiple hand mobility tests in two relatively large cohorts, in which many other clinical and radiological data were available, allowing an extensive comparison of metric properties among these tests, using OMERACT methodology. Although the cohorts included two clinically distinct hand OA populations, which is reflected by the differences in baseline characteristics, we observed similar results, adding to the validity of these findings. However, some limitations have to be acknowledged. Measurement of range of motion using a goniometer is also regularly performed to estimate joint mobility, but we did not assess this. It is, however, time-consuming, and reported reproducibility is variable.[29] The hand functional index (HFI) is another test of joint mobility, consisting of nine items from the more widely known Keitel Function Test, which we did not assess.[30] The HFI was developed for RA, although one study looked in hand OA patients and reported a moderate correlation with self-reported function.[14] Since the HFI was used as a template to develop the HAMIS, items from these tests largely overlap, and metric properties in hand OA patients will likely be similar.[6] Another limitation is that the number of participants in the CMC OA subgroup was rather small, and conclusions based on those results should therefore be drawn with caution. Moreover, most participants did not exhibit major limitations in hand mobility, which may very well reflect the average hand OA patient, although ideally to assess metric properties of a test one would like to include patients in all ranges of the scale. Also, the percentage of women in both cohorts was high, and although this reflects a typical cohort of hand OA patients, it precluded a detailed assessment whether our results are generalizable to both sexes. Finally, as outlined above, we were not able to assess sensitivity-to-change after an intervention in our data, and this needs to be done in further studies.

In conclusion, our data suggest that FPD, MKI, HAMIS and the number of joints assessed for the presence of limited mobility are all valid, reliable and feasible measures to assess hand mobility in hand OA patients, although HAMIS had slightly more favourable properties. Future hand OA studies should incorporate hand mobility as an outcome measure, to enhance the knowledge on this outcome in hand OA.

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