

Hand function assessment in patients receiving haemodialysis

Mehmet Tuncay Duruöz^a, Lale Cerraboglu^a, Yasemin Dincer-Turan^a, Seybun Kürsat^b

^a Physical Medicine and Rehabilitation Department, Celal Bayar University Medical School, Manisa, Turkey

^b Internal Medicine Department, Nephrology Division, Celal Bayar University Medical School, Manisa, Turkey

Summary

Objective: To assess the usefulness of Duruöz's Hand Index (DHI) in patients undergoing haemodialysis.

Methods: Patients receiving haemodialysis for more than 2 months were recruited randomly. Demographic, clinical and functional characteristics of patients were evaluated. Functional assessment was performed with DHI, Hand Functional Index (HFI), Health Assessment Questionnaire (HAQ), Purdue Pegboard, grip strength and 3 kinds of pinch strengths. DHI was correlated (Spearman's) with the other functional parameters in assessing the convergent validity and with non-functional parameters in assessing the divergent validity.

Results: Sixty patients with a mean age of 50.05 were recruited. The average duration of haemodialysis was 55.02 months. DHI is significantly correlated with HAQ, HFI, Purdue Pegboard scores, grip strength and 3 types of pinch strengths while no significant correlation was found with non-functional parameters.

Conclusions: DHI is a practical scale which is efficient in assessing accurately the functional disability of the hand in patients receiving haemodialysis.

Key words: haemodialysis; hand; function; disability; index

Introduction

Dialysis-associated musculo-skeletal pathologies often present with carpal tunnel syndrome, juxta-articular bone cysts or erosions, and destructive spondyloarthropathy that occur in patients with chronic renal failure [1]. A variety of arthritic and neuromuscular syndromes, unrelated to crystalline-induced arthritis, were described with the wide use of dialysis to treat end-stage renal failure. Although the first symptoms antedate dialysis in a few patients, onset usually occurs after many years under chronic dialysis [2].

During the last decade, a new form of amyloidosis was recognised in patients with chronic renal failure. This type of amyloidosis is characterised by the deposition of β_2 -microglobulin (β_2 M) predominantly in articular and periarticular tissues. Dialysis related β_2 M amyloidosis is a disorder that commonly develops in long-term dialysis patients [3] and is a different entity from dialysis-associated arthropathy [2]. Both pathologies may cause important musculoskeletal disorders and some functional limitations. Secondary amyloidosis can also occur in a variety of chronic inflammatory condi-

tions such as rheumatoid arthritis, familial Mediterranean fever and bronchiectasis [4].

Hand involvement in chronic renal disease has been known for a long time. In 1939, Koletsky and Stetcher reported the rheumatic complaints resulting from amyloidosis. These symptoms included swelling and stiffness of the hand associated with tingling and burning sensations (carpal tunnel syndrome) [5]. Hand function in patients with dialysis related pathology was assessed previously in a few studies [6, 7]. In one study, hand function was assessed by a medico legal technique based on sensitivity and amplitude of angulations [6]. The other study used the Sollerman test (activities related with grip strength) [8] and a grip strength test with Jamar dynamometer [7]. These tests mostly assess impairment of the hand rather than disability or handicap. Therefore, in this study, we aimed to assess if Duruöz's Hand Index [9] was a useful instrument to evaluate functional disability in patients undergoing haemodialysis.

Medical research suggests that disease can lead to impairment first and then disability, but that

either can lead to handicap [10]. The clinician is mostly concerned with reducing pain, fatigue (impairment), maintaining or improving ability to perform activities of daily living (disability), and maintaining or improving independence (handicap) [11].

Although there are some scales to assess hand function, none of them was developed specifically for hand involvement in patients receiving

haemodialysis. Duruöz's Hand Index (DHI) (Appendix) is a functional disability scale which was developed for the rheumatoid hand [9]. It has also been cross validated for hand involvement of osteoarthritis [12] and systemic sclerosis [13] and its significant correlation with reducing of the bone mineral content (BMC) of the rheumatoid hand has been shown [14].

Patients and methods

Patients

Patients receiving hospital or community based haemodialysis for more than 2 months, through the Celal Bayar University Medical School Hospital were recruited randomly into the study. Patients were excluded on the basis of the following criteria: i) neurological disorders of the upper limbs, ii) restricted hand motion due to skin lesions and Dupuytren's contracture, iii) inflammatory arthritis, iv) upper limb arthroplasty, amputation or joint fusion; hand and wrist surgery or trauma within the last 90 days, and v) severe psychiatric disorders.

Methods

Demographic data were obtained, along with details of haemodialysis (frequency, duration, dialyser type and membrane), prior renal transplantation, duration of renal failure, parathyroidectomy, hand dominance, carpal tunnel syndrome, fistula localisation, prior surgical intervention of hands, morning stiffness, body mass index (BMI).

Haemoglobin, haematocrit, white blood cell count (WBC), platelets, blood urea nitrogen (BUN), amino-transferases, glucose, cholesterol, uric acid, albumin, total protein, alkaline phosphatase, calcium, potassium, sodium were examined in blood.

The swelling of 15 joints (Wrist, thumb's IP, 5 × MCP, 4 × PIP, 4 × DIP) were assessed. Pain was assessed using the visual analogue scale of pain in hands (VAS-hand) and in upper extremities (VASupext) over the past 24 hours. The Health Assessment Questionnaire (HAQ) [15], Hand Functional Index (HFI) [16], and DHI were used in the assessment of function.

The HAQ has 8 groups of questions concerning activities of daily living. The scores are determined by standard methods and the total score may range from 0 to 3. The HFI consists of the first 9 questions of the Keitel Functional Test [17]. It is an observational hand scale which assesses finger and wrist motion and the total score ranges from 4 to 42. DHI has 18 questions of activities of daily living that are administered by an interviewer. These questions can be categorised into 3 groups of factors according to factor analysis [9]. The first factor represents activities requiring force and rotational motions (Questions 2, 3, 5, 6, 11, 12, 15, 18), the second factor represents activities requiring dexterity and precision (Questions 1, 4, 7, 8, 9, 10) and the third factor represents dynamic activities requiring flexibility of the first 3 fingers (Questions 13, 14, 16, 17). Each item is scored on a 6-point Likert scale (0 to 5) and the patients answered the questions based on their experience during the last week.

We assessed grip strength and 3 types of pinch strength (tip pinch, lateral or key pinch, chuck or three finger pinch) for the dominant (D) and non dominant (ND) hands of each patient by two different kinds of JAMAR hand dynamometers (JA Preston Corp, Ontario, Canada)

which measure isometric muscle contraction. The measurements were performed while the patients were seated with the shoulders adducted, elbows flexed to 90°, and forearms in neutral position [18]. The tests were performed three times, and the results were averaged to give the final result in kilograms of force.

Fingertip dexterity and hand co-ordination were assessed by "Purdue Pegboard Model # 32 020" (Lafayette Instrument Company, IN, USA). The patients were informed about the test and instructed clearly and were given the opportunity to practice before starting each test [19]. They were allowed to practise each test 4 or 5 times to ensure they fully understood the procedure.

The test administrator compiled 3 separate scores: i) pick up pins and place them in row with the dominant hand (pins_D), ii) previous test with the non dominant hand (pins_ND), iii) assembly test.

For the "pins test" the test administrator said: "Pick up one pin at a time with your dominant / non dominant (D/ND) hand from the D/ND hand row, starting with the top hole." They were instructed to start the test and work as rapidly as they could until they were told to stop. The test was carried out for exactly 30 seconds.

The "assembly test" battery consists of assembling pins, collars and washers. The test administrator demonstrated the following procedures while saying: "Pick up one pin from the D-hand cup with your D-hand. While you are placing it in the top hole in the D-hand row, pick up a washer with your ND-hand. As soon as the pin has been placed, drop the washer over the pin. While the washer is being placed over the pin with your ND-hand, pick up a collar with your D-hand. While the collar is being dropped over the pin, pick up another washer with your ND-hand and drop it over the collar. This completes the first 'assembly', consisting of a pin, a washer, a collar, and a washer. While the final washer for the first assembly is being placed with your ND-hand, start the second assembly immediately by picking up another pin with your D-hand. Place it in the next hole, drop a washer over it with your ND-hand, and so on, completing another assembly". It was emphasised that both hands should be operating at all times: one picking up a pin, one a washer, one a collar, and so on. The patients were given 60 seconds for the test and the "assembly" score was determined by counting the number of parts assembled. For the "pick up pins test" a score was awarded according to the number of pins inserted in 30 seconds. For the "assembly test" a score was awarded on the basis of the number of pieces inserted in 60 seconds.

Construct validity of DHI was investigated in 2 ways: i) Convergent validity was assessed by correlating global scale score with variables that we would expect to have a converging relationship (functional parameters); ii) Divergent validity was assessed by the correlation of the

global scale score with variables considered to have a moderate or minimal relationship with functional disability [9].

Statistical Analysis

Quantitative variables were described using means, standard deviations (SD), medians, interquartiles range and 95% confidence intervals for mean. Qualitative vari-

ables were described using proportion and percentage. The nonparametric Spearman rank correlation coefficient (rho) was used to assess the correlation between 2 quantitative variables. Pearson's coefficient could not be used with confidence, because the sampled populations did not have bivariate normal distribution. The level of significance in all tests was p <0.05.

Results

Sixty patients (30 male) with a mean age of 50.05 (SD: 13.36) took part in the study. Causes of chronic renal failure were unknown (41.7%), chronic pyelonephritis (13.3%), polycystic kidney disease (8.3%), glomerulonephritis (8.3%), drug nephropathy (6.7%), hypertensive nephropathy (5.0%), diabetes mellitus (3.3%) and congenital hypoplastic kidney, hypertensive nephropathy, nephrolithiasis, primary kidney disease, multiple myeloma, reflux nephropathy, IgA nephropathy, primary amyloidosis (1.7% each). Table 1 shows

demographic characteristics of patients. Two patients had peritoneal dialysis and two patients had undergone a failed renal transplantation previously. The average duration of haemodialysis was 55.02 months (SD: 50.58). Fifty-eight patients were dialysed three times a week and 2 patients were dialysed 4 times a week for four hours, using bicarbonate buffer, and cellulose diacetate membranes. The fistula was in the non-dominant arm in 78.3% of patients. Patients had not undergone parathyroidectomy, surgical interventions in hands, nor did they have carpal tunnel syndrome. Fifty-seven patients (95%) were right handed. Table 2 shows the functional characteristics of subjects. The average score of DHI was 5.57 (SD: 11.18) and 48.3% of patients had a score of zero. The average scores of the HFI and HAQ were 7.78 (SD: 5.50) and 0.41 (SD: 0.56) respectively. Patients who had the minimum score for HFI (four points) and HAQ (zero) were 48.3% and 45.0% respectively.

The dominant hand (D) scores were marginally higher than the non dominant hand (ND) scores for Purdue Pegboard tests, grip strength (JAMAR for grip) and pinch strength (JAMAR for

Table 1
Demographic and clinical characteristics of subjects (n = 60).

Age (year):	50.05 (SD: 13.36; min-max: 17-70)
Gender (F/M):	30 / 30
Right handed (%):	95
Body Mass Index (kg/m ²):	22.06 (SD: 3.98; min-max: 14.87-32.85)
Fistula (ND-D arm: %):	78.3-21.7
Renal failure duration (months):	69.18 (SD: 60.08; min-max: 3-279)
Haemodialysis duration (months):	55.02 (SD: 50.58; min-max: 2-250)

D: Dominant hand; ND: Non dominant hand.

Table 2
Functional characteristics of subjects (n = 60).

	Mean	SD	Median	IQR	95% CI for Mean	
					lower	upper
DHI (range: 0-90)	5.57	11.18	1.00	0-6.00	2.68	8.45
DHI-Factor 1 (range: 0-40)	2.78	5.18	0	0-3.00	1.44	4.12
DHI-Factor 2 (range: 0-30)	1.38	3.20	0	0-1.00	0.56	2.21
DHI-Factor 3 (range: 0-20)	1.40	3.20	0	0-1.00	0.57	2.23
HFI (range: 4-50)	7.78	5.50	6.00	4.00-12.00	6.36	9.20
HAQ (range: 0-3)	0.41	0.56	0.19	0.00-0.72	0.27	0.56
Pins_D	12.00	2.18	12.33	10.33-13.58	11.44	12.56
Pins_ND	11.00	2.18	11.50	9.67-12.67	10.44	11.56
Assembly	20.99	5.31	21.17	18.33-24.44	19.62	22.36
Grip Strength_D (kg-force)	22.99	9.54	21.67	15.60-27.46	20.52	25.45
Grip Strength_ND (kg-force)	19.29	8.34	18.67	12.67-25.71	17.14	21.45
Tip Strength_D (kg-force)	5.54	1.94	5.23	3.92-6.67	5.04	6.04
Tip Strength_ND (kg-force)	4.89	1.62	4.83	3.58-6.15	4.47	5.31
Lateral Strength_D (kg-force)	6.72	2.13	6.67	5.13-7.83	6.17	7.27
Lateral Strength_ND (kg-force)	6.06	2.05	5.92	4.85-7.23	5.53	6.59
Chuck Strength_D (kg-force)	5.94	1.71	5.54	4.75-7.40	5.50	6.38
Chuck Strength_ND (kg-force)	5.40	1.59	5.54	4.15-6.67	4.99	5.81

D: Dominant hand; ND: Non dominant hand; IQR: Inter quartiles range.

Table 3

Spearman's Correlation Coefficient of DHI with functional and clinical parameters.

	DHI	DHI-Factor 1	DHI-Factor 2	DHI-Factor 3
HFI	0.447 (<0.0001)	0.434 (<0.0001)	0.517 (<0.0001)	0.270 (0.037)
HAQ	0.805 (<0.0001)	0.799 (<0.0001)	0.689 (<0.0001)	0.749 (<0.0001)
Pins_D	-0.342 (0.007)	-0.318 (0.013)	-0.291 (0.024)	-0.369 (0.004)
Pins_ND	-0.365 (0.004)	-0.338 (0.008)	-0.397 (0.002)	-0.321 (0.012)
Assembly	-0.302 (0.019)	-0.275 (0.034)	-0.365 (0.004)	-0.318 (0.013)
Grip Strength_D	-0.536 (<0.0001)	-0.604 (<0.0001)	-0.422 (0.001)	-0.422 (0.001)
Grip Strength_ND	-0.547 (<0.0001)	-0.622 (<0.0001)	-0.459 (<0.0001)	-0.353 (0.006)
Tip Strength_D	-0.392 (0.002)	-0.459 (<0.0001)	-0.319 (0.013)	-0.356 (0.005)
Tip Strength_ND	-0.429 (0.001)	-0.510 (<0.0001)	-0.369 (0.004)	-0.350 (0.006)
Lateral Strength_D	-0.347 (0.007)	-0.428 (0.001)	-0.262 (0.043)	-0.383 (0.003)
Lateral Strength_ND	-0.372 (0.003)	-0.449 (<0.0001)	-0.308 (0.017)	-0.393 (0.002)
Chuck Strength_D	-0.347 (0.007)	-0.417 (0.001)	-0.330 (0.010)	-0.336 (0.009)
Chuck Strength_ND	-0.410 (0.001)	-0.465 (<0.0001)	-0.374 (0.003)	-0.340 (0.008)
VAS-hand	0.246 (0.058) NS	0.238 (0.067) NS	0.322 (0.012)	0.128 (0.331) NS
VAS-upext	0.202 (0.121) NS	0.084 (0.523) NS	0.296 (0.021)	0.198 (0.130) NS
Morning stiffness	0.124 (0.347) NS	0.104 (0.428) NS	0.152 (0.246) NS	0.161 (0.218) NS

NS: Non significant.

pinch) as however there were no remarkable differences between the results for D and ND scores, these data were merged for all tests. All functional tests were skewed. Most of the patients did not report pain in the hands (VAShand) (96.7%) and in the upper extremities (VASupext) (76.7%). Ninety percent of the patients did not complain of any morning stiffness in the hands while the rest had a morning stiffness lasting less than 15 minutes (i.e., exclusion criteria were successfully employed).

DHI was not found to have any significant relation with 16 laboratory blood tests, VAShand, VASupext, morning stiffness, duration of renal failure and duration of haemodialysis. Table 3 shows the correlation coefficient of DHI and with functional and clinical data. It was significantly correlated with all functional parameters and the strongest correlation was found between DHI and HAQ.

Discussion

The accumulation and deposition of β_2 microglobulin (polypeptide) in musculoskeletal structures in patients under haemodialysis leads to amyloidosis. The functional consequences and outcomes of β_2 microglobulin deposition in the hand can be evaluated. A functional hand scale specific for patients receiving haemodialysis has not been developed thus far. Some practical, accurate and commonly used hand scales such as DHI may be cross validated for this purpose.

Chronic haemodialysis patients often have lesions of the hands characterised by distinctive aetiopathogenic mechanisms and functional consequences. Carroll et al. indicated that disuse led to hand dysfunction, even in the absence of anatomic hand disease and they found that the motor function and co-ordination were abnormal in two-thirds of the hands [20]. The percentage of impaired hand function with scoring above the normal value in our patients as indicated by DHI, HFI and HAQ was respectively 51.7%, 51.7% and 55%. These results are similar to the previous study in which the incidence of impaired hand function in patients undergoing haemodialysis was

found to be 54% [7]. The mean score (Mean: 5.57; SD: 11.18) of DHI was not high. The mean scores of Purdue Pegboard (pin scores, assembly scores), grip strength and pinch strengths of our group were lower than normative data which were published previously [19, 21]. Although hand function decreases in patients receiving haemodialysis, the loss is not severe.

Asencio et al. mentioned that the rate of occurrence of hand lesions increased after ten years on haemodialysis, with devastating functional consequences [22]. They assessed hand function with a technique based on sensitivity and amplitude of angulations. These tests evaluate the impairment, and not disability. We did not find any significant correlation between functional disability (DHI) and duration of haemodialysis. The level of impairment does not reflect the level of disability. Probably, daily activities are modified by patients with chronic diseases as coping strategies.

Although the incidence of carpal tunnel syndrome (CTS) in large groups of dialysis patients has ranged from 2 to 31% [3, 21], there was not any CTS in our group. Previously it has been

shown that 85% of patients undergoing haemodialysis for more than 10 years develop CTS due to local amyloid deposits [23].

Shoulder involvement is a common feature in long term haemodialysis patients and increased rotator cuff thickness, signal intensity changes, and synovial abnormalities are early signs of haemodialysis related arthropathy [24]. Arthralgias are a prominent feature; they predominantly involve the shoulders, are usually bilateral and often worsen during dialysis sessions [25]. Elbow-shoulder pain was more frequent than hand pain in our study. Only 3.3% of patients had pain in their hands (VASHand) while 23.3% of them had pain in the elbows and/or shoulders (VASupext).

Because there is no gold standard to assess functional disability [26], we may assess the convergent and divergent validities to evaluate the usefulness of DHI in patients receiving haemodialysis. Although DHI is found to be significantly correlated with all functional parameters (Table 3), no correlation exists with non-functional parameters. This shows that DHI has good convergence with functional parameters and has divergence with other parameters.

A moderate correlation was observed between DHI and HFI. As the HFI assesses impairment, a correlation of this magnitude would be acceptable. This demonstrates that the scales are assessing related but different constructs.

A high correlation was observed between the DHI and the HAQ. This is an interesting finding as the HAQ is a measure of whole body disability. However, many of the items contained in the HAQ relate to disabilities that would be affected by a reduction in hand functioning. Furthermore, for this

patient group, it is likely that disability of the whole body would be strongly related to hand activities.

As no significant correlations were observed between the DHI and the non-functional parameters we can be confident that scale scores are not affected by factors such as morning stiffness and duration of haemodialysis. Thus we can be confident that the DHI assesses only functional disability.

Thus, DHI is a discriminative functional test for assessing functional disability in patients undergoing haemodialysis. The practical advantages of DHI are clarity, comprehensiveness, simplicity, and a minimum requirement of professional time and money. It also indicates the kinds of activities and factors that result in functional disability enabling us to individualise hand treatment strategies more specifically.

In conclusion, hand functions decrease moderately in patients receiving haemodialysis without any significant relation to the blood tests. DHI is a practical evaluation system which was validated in 3 different types of arthropathies involving the hands previously [9, 12, 13] and according to our study it is also useful in assessing the functional disability of the hand accurately in patients receiving haemodialysis.

Correspondence:

*Yard. Doc. Dr. M Tuncay Duruöz,
EVKA 3 Mah. 126 / 8 Sok. No: 3
Bornova 35050
Izmir/Turkey
E-mail: duruoz@superonline.com*

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Appendix

The English version of Duruöz's Hand Index (DHI).

Answers to the questions:

0 = Yes, without difficulty,

1 = Yes, with a little difficulty,

2 = Yes, with some difficulty,

3 = Yes, with much difficulty,

4 = Nearly impossible to do,

5 = Impossible.

Answer the following questions regarding your ability without the help of any assisting devices.

C1 - In the kitchen

1. Can you hold a bowl?

2. Can you seize a full bottle and raise it?

3. Can you hold a plate full of food?

4. Can you pour liquid from a bottle into a glass?

5. Can you unscrew the lid from a jar opened before?

6. Can you cut meat with a knife?

7. Can you prick things well with a fork?

8. Can you peel fruit?

C2 - Dressing

9. Can you button your shirt?

10. Can you open and close a zipper?

C3 - Hygiene

11. Can you squeeze a new tube of toothpaste?

12. Can you hold a toothbrush efficiently?

C4 - In The Office

13. Can you write a short sentence with a pencil or ordinary pen?

14. Can you write a letter with a pencil or ordinary pen?

C5 - Other

15. Can you turn a round door knob?

16. Can you cut a piece of paper with scissors?

17. Can you pick up coins from a table top?

18. Can you turn a key in a lock

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