Evaluation of hand function in patients undergoing long term haemodialysis

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Ann Rheum Dis 2001;60;278-280
doi:10.1136/ard.60.3.278

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Abstract

***Objective*—Haemodialysis is associated with the deposition of β_2 microglobulin in musculoskeletal structures, leading to the syndrome of dialysis related amyloidosis and impairment of hand function. This study aimed at assessing hand function using the Sollerman test in a cross section of patients undergoing haemodialysis.**

***Methods*—Recipients of haemodialysis underwent the Sollerman test of hand grip function, which assesses 20 activities of daily living using eight grip types, and the JAMAR grip strength test, visual analogue scales (VAS) for pain (VAS-P) and function (VAS-F), and Health Assessment Questionnaire (HAQ) were determined.**

***Results*—Thirty five subjects (26 male), with mean age 53.2 years, participated. The average duration of haemodialysis was 6.2 years (range one month to 25 years). The median Sollerman score was 77, with 19/35 (54%) patients receiving haemodialysis having a score below the lower normal value of 78–80. The log Sollerman score correlated poorly with age (r_s=0.16, p=0.35), and significantly with the HAQ score (r_s=−0.66, p<0.00005), duration of haemodialysis (r_s=−0.39, p<0.05), VAS-F (r_s=−0.41, p<0.05), VAS-P (r_s=−0.34, p<0.05), and JAMAR score (r_s=0.57, p<0.05). Sollerman scores were highly correlated between dominant and non-dominant hands (r_s=0.69, p<000005).**

***Conclusions*—Hand dysfunction is a common finding among patients undergoing long term haemodialysis. The Sollerman test accurately reflects patient function as measured by HAQ, VAS-F, and grip strength, but less so pain. Its use for the early detection of dialysis related amyloidosis and in the serial monitoring of the effects of hand treatment programmes is encouraged.**

(*Ann Rheum Dis* 2001;**60**:278–280)

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Accepted 6 July 2000

Haemodialysis in chronic renal failure does not adequately restore all avenues of normal renal function. Clinically relevant is the retention and preferential deposition in musculoskeletal structures of β_2 microglobulin, an 11.8 kDa polypeptide.[1] The clinical manifestations of this deposition are broadly known as dialysis related amyloidosis, and include a destructive arthropathy,[2] erosive spondyloarthropathy,[3] and bone cysts.[4] Carpal tunnel syndrome is common and, together with flexor tendon contractures and trigger finger, is known to affect hand function adversely,[5] which may, in turn, impede activities of daily living.

Measurement of hand function in patients with dialysis related amyloidosis is not well described. A single study of hand function used a method devised for medicolegal purposes and not primarily to reflect hand grips as needed in activities of daily living.[5] The Sollerman test assesses unilateral and bilateral hand grip function in activities of daily living.[6] This test has been validated against other tests of hand function (Jebsen test of hand function),[7 8] and inter-rater coefficient of reliability is high, r=0.98 (Doehr SL, unpublished data).

We aimed at undertaking a cross sectional analysis of hand grip function using the Sollerman test in patients receiving haemodialysis, and correlating this test with other measures used to evaluate the functional impact of arthropathy.

Patients and methods

PATIENTS

Patients receiving hospital or community based haemodialysis for more than one month, through the Queen Elizabeth Hospital, were invited to participate after obtaining their informed consent. Inflammatory arthritis and peripheral neuropathy were exclusion criteria.

GENERAL

Demographic data were obtained, along with details of haemodialysis (frequency, duration, dialyser type, and membrane), prior renal transplantation, parathyroidectomy, hand dominance, carpal tunnel syndrome, and symptoms of peripheral/axial arthritis. The visual analogue scale for pain, VAS-P (place a vertical mark on the line below to represent the pain you experienced in your hands over the past 24 hours) and function, VAS-F (consider the way your hands are affected and place a vertical mark on the line below to represent how you are doing), and the Health Assessment Questionnaire (HAQ) scores were determined by standard techniques. All subjects underwent the JAMAR test (JA Preston Corp, Ontario, Canada) for hand grip strength and the Sollerman test (Exelfort Pty Ltd, Cottesloe) for the dominant (D) and non-dominant (ND) hands with a single occupational therapist. The JAMAR hand dynamometer measures grip strength by isometric muscle contraction, and is performed in the sitting position, with the shoulder adducted, elbow flexed to ninety degrees, and forearm and wrist in neutral positions. The test is performed three times, and the results averaged to give the final result.[9] Of five possible settings, the second

Table 1 Range of scores for Health Assessment Questionnaire (HAQ), visual analogue scales for pain, VAS-P (reflecting the pain felt in the hands in the past 24 hours), and function, VAS-F (reflecting the patients' assessment of "how they are doing"), JAMAR and Sollerman scores in the dominant (D) and non-dominant (ND) hands

	HAQ	*VAS-P*	*VAS-F*	*JAMAR-D (kg)*	*JAMAR-ND (kg)*	*Sollerman-D*	*Sollerman-ND*
Mean	4.8	18.7	22.2	25.0	22.8	75.6	74.9
SD	5.3	28.8	29.4	11.4	12.1	5.3	5.7
Median	3	2	3	25	21.5	77	77
Range	0–19.0	0–100.0	0–100.0	3.0–48.0	6.0–46.0	53.0–80.0	55.0–80.0

setting was used for all subjects, and results recorded as kilograms of force.

SOLLERMAN TEST

The Sollerman test uses 20 items comprising activities of daily living tasks; 15 items test bilateral hand grip function, and seven of the grips assessed are essential for normal function. The eight main grip types are tested in the following proportions: pulp pinch 20%, lateral pinch 20%, tripod pinch 10%, five finger pinch 15%, diagonal volar grip 15%, transverse volar grip 14%, spherical volar grip 4%, and extension grip 2%. Points are assigned to each item on a five level scale; the final score is the sum of all items. Possible scores range from zero to 80; subjects with normal hand function should achieve scores of 80 and 78–80 in the dominant and non-dominant hands respectively.

STATISTICAL ANALYSIS

Statistical comparison used the Spearman correlation coefficient, linear regression analysis, and Student's *t* test ($p<0.05$ significant). The study was approved by the Queen Elizabeth Hospital ethics of human research committee.

Results

Thirty five patients (26 male) aged 24–84 years (mean (SD) 53.2 (15.2)) participated. Causes of chronic renal failure were glomerulonephritis (9/35, 26%), unknown cause (9/35, 26%), reflux nephropathy (5/35, 14%), polycystic kidney disease, diabetes mellitus, and IgA nephropathy each 2/35, (6%), Alport's disease, pre-eclampsia, Goodpasture's syndrome, lithium toxicity, renovascular disease, and primary amyloidosis each 1/35 (3%). Ten patients had undergone a previous failed renal transplantation, with three patients having received three transplants. The average graft survival was 4.4 years (range from one never functioning graft to 28 years). The duration of haemodialysis (excluding periods of functioning renal allografts) ranged from one month to 25 years (mean 6.2 (7.8) years, median 2 years). All patients were dialysed three times a week for four hours, using bicarbonate buffer, and predominantly polysulphone membranes (one patient used a cellulose membrane and one used a triacetate membrane). The fistula was in the non-dominant arm in 20/35 (57%) subjects. Seven patients had undergone parathyroidectomy, nine had previous surgically corrected carpal tunnel syndrome, 17 had symptoms of peripheral arthritis, and 13 had symptoms of axial arthropathy.

Table 1 shows the mean, median, and range of scores obtained for HAQ, VAS-P, VAS-F, JAMAR-D, JAMAR-ND, Sollerman-D, and Sollerman-ND. The median Sollerman score was 77, with 19/35 (54%) patients receiving haemodialysis having a score below the lower normal value of 78–80. The frequency distributions for Sollerman scores (dominant and non-dominant) were skewed (marked clustering between 73 and 80), hence the scores were log transformed for statistical analysis. Although the frequency distributions for HAQ, VAS-P, and VAS-F were also skewed, log transformation was not performed because a large proportion of subjects had scores of zero.

Table 2 Correlation of log Sollerman score in the dominant hand (Sollerman-D) with age, duration of dialysis, Health Assessment Questionnaire (HAQ), visual analogue scales for pain, VAS-P (reflecting the pain felt in the hands in the past 24 hours) and function, VAS-F (reflecting the patients' assessment of "how they are doing"), JAMAR score in the dominant hand (JAMAR-D), and the log of the Sollerman score in the non-dominant hand (Sollerman-ND)

	Log Sollerman-D
Age	r_s =0.16, p=0.35
Duration	r_s =−0.39, p<0.05
HAQ	r_s =−0.66, p<0.00005
VAS-P	r_s =−0.34, p<0.05
VAS-F	r_s =−0.41, p<0.05
JAMAR-D	r_s =0.57, p<0.05
Log Sollerman-ND	r_s =0.69, p<0.000005

r_s = Spearman's correlation coefficient.

There was no significant difference between the Sollerman scores for the dominant and non-dominant hands and therefore other comparisons were made with the Sollerman score for the dominant hand only (table 2). There was no correlation between Sollerman scores and age. The Sollerman score correlated most strongly with the HAQ score but also correlated with the duration of dialysis, VAS-P, VAS-F, and JAMAR-D.

Discussion

Of the total daily synthesis of β_2 microglobulin (150–200 mg),[10] only a small fraction is removed by haemodialysis. With haemodialysis, the accumulation and deposition of this polypeptide in musculoskeletal structures leads to dialysis related amyloidosis. Age above 40 years at the start of dialysis,[11] duration of haemodialysis,[12] and the use of cuprophane membranes are identified risk factors.

The Jebsen test is a norm referenced instrument which provides a quantitative measure of seven aspects of unilateral hand function, and assesses the speed, rather than the quality of the performance.[7] The time taken to perform the Jebsen test is strongly correlated with scores obtained using the Sollerman test.[8] The Sollerman test is a more sensitive measure of functional performance than the Jebsen test, as indicated by the patients' subjective estimation of hand function.[8] The two tests, however, provide distinct information, and the test used depends on the criterion of hand function to be assessed.

The incidence of impaired hand function in our group undergoing haemodialysis, as indicated by the Sollerman test, was substantial, with 19/35 (54%) patients scoring below the lower normal value. The negative correlation of the log Sollerman-D score with the HAQ,

VAS-P, and VAS-F scores (table 2) indicates that measurement of hand function by the Sollerman test accurately reflects the patients' subjective assessment of pain and functional limitation. By extrapolation, reducing pain and improving function should lower the HAQ, VAS-P, and VAS-F scores, and simultaneously improve the Sollerman scores. This measure, therefore, could be used in serial measurements in following up patients with dialysis related amyloidosis, and documenting objectively the effect of interventional strategies (for example, hand treatment programmes).

Once functional limitation from β_2 microglobulin deposition has developed, the limitation as indicated by the Sollerman test seems to be bilateral—there was no significant difference in the Sollerman scores between the dominant and non-dominant hands. Grip strength as indicated by the JAMAR test correlated well with the Sollerman-D score (r_s=0.57, p<0.05) and it is not surprising that hand functional impairment should occur in parallel with a reduction in grip strength.

Reduction in the Sollerman-D score with increasing duration of haemodialysis (table 2) is biologically plausible, and duration of haemodialysis is an identified risk factor for the development of dialysis related amyloidosis.[12] The Sollerman score was independent of age (p=0.35, r_s=0.16) within the age range studied (24–84 years), and this test therefore appears suitable for a wide age group.

The wide range in age and duration of haemodialysis of our study group are the major limitations of this study. Furthermore, although dialysis related amyloidosis was the presumed cause of hand dysfunction, patients with other comorbidities affecting hand function were excluded. The use of the Sollerman test in other conditions in which hand dysfunction is common (for example, rheumatoid arthritis) has not been evaluated, and application of this test to such conditions may prove similarly beneficial.

The functional consequences of β_2 microglobulin deposition in the hand can be debilitating. We have, for the first time, shown that the Sollerman test reliably measures such alteration in hand function in activities of daily living. This test, unlike the HAQ, VAS-P, and VAS-F, requires active patient participation, while maintaining an objective, validated scoring system. We propose its use for the detection of dialysis related amyloidosis, and thereby target those at risk for the use of the more biocompatible membranes. Individualised hand treatment programmes, targeting areas of deficiency identified by the Sollerman test should be implemented, and the use of this test in serial measurements is encouraged.

The authors acknowledge the assistance of the dialysis staff at The Queen Elizabeth Hospital and associated satellite centres.

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