Musculoskeletal disorders in hemodialysis patients and its impact on physical function (Zagazig University Nephrology Unit, Egypt)

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Background
A number of musculoskeletal disorders have been reported in hemodialysis (HD) patients and they exert an impact on their functional status.

Objectives
This study was designed to determine the most common musculoskeletal system involvement in chronic HD patients and to show its effect on physical function (disability).

Patients and methods
This study was carried out on HD patients at the Nephrology Unit in Zagazig University Hospitals, Egypt. Pain intensity was measured using a 100-mm pain visual analogue scale. Physical disability was measured using the Health Assessment Questionnaire. A blood sample was obtained to measure calcium, phosphorus, alkaline phosphatase, parathyroid hormone, serum uric acid, serum albumin, serum iron, serum ferritin, and transferrin. Radiography of the symptomatic joints was performed. Dual-energy x-ray absorptiometry was performed at the femoral neck and the lumbar spine.

Results
Of the 144 HD patients, 87 patients (60.4%) had musculoskeletal manifestations. The most common musculoskeletal disorder was joint pain (arthralgia) (25.3%), followed by osteoarthritis (17.2%), carpal tunnel syndrome (14.9%), and osteoporosis (13.7%). The results of dual-energy x-ray absorptiometry showed that the median T-score was −1.43 of the hip and −2.76 at the lumbar spine. There were highly significant positive correlations between the duration of HD and parathyroid hormone ($P < 0.02$). Higher Health Assessment Questionnaire scores were significantly associated with shoulder pain ($P < 0.02$), wrist pain ($P < 0.03$), small joint pain ($P < 0.01$), knee pain ($P < 0.04$), hip pain ($P < 0.04$), osteoarthritis ($P < 0.02$), and osteoporosis ($P < 0.00$).

Conclusion
Musculoskeletal system involvement remains a common problem that limits the physical function of patients with renal failure, in particular, those treated with long-term maintenance dialysis.

Keywords:
disability, hemodialysis, musculoskeletal, physical function

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Introduction

End-stage renal disease (ESRD) is a major public health problem. In the USA, more than 350 000 patients with ESRD are being treated by dialysis, with about 92% receiving hemodialysis (HD) and about 8% on continuous ambulatory peritoneal dialysis (PD) [1]. The incidence of ESRD in Taiwan has increased in the last decade and reached the highest incidence in the world. The prevalence of ESRD was 1706 per million population in Taiwan, second only to Japan [2]. There is still a paucity of data on the prevalence and risk factors of chronic kidney disease (CKD) in the Middle East. In Egypt, according to the most recent Egyptian renal registry in 2008, the prevalence of ESRD is 483 per million population and the total recorded number of ESRD patients on dialysis is 40 000. Ninety-eight percent of these patients are on HD and 2% on PD [3].

Long-term regular HD for chronic renal failure for at least 14 years (average 15.7 years) was associated with repeated problems with vascular access surgery and different medical problems mainly involving the musculoskeletal system [4]. Most of the interest in musculoskeletal problems secondary to renal disease has focused on problems occurring in patients with chronic renal failure and specifically in patients on long-term HD [5]. The musculoskeletal involvement in long-term HD may involve the joints, soft tissues, or both. Crystal-induced arthropathy, most commonly caused by basic calcium phosphate crystals, is an important cause of acute joint inflammation in patients with renal

failure [6]. A triad of shoulder periarthritis, carpal tunnel syndrome (CTS), and flexor tenosynovitis of the hands has been described in patients on long-term HD and PD and has been attributed to β2-microglobulin amyloid deposition [4]. The incidence of septic arthritis has increased in patients undergoing dialysis. Dialysis is also associated with an erosive or a destructive arthropathy of the finger joints, which is not explained by local amyloid deposition [6].

ESRD patients usually have accelerated bone loss because of abnormal bone turnover that leads to a high prevalence of bone health problems, for example, osteopenia and osteoporosis [7]. Furthermore, parathyroid hormone (PTH)-related bone disease influences bone mineral density (BMD) in HD patients, in addition to other important risk factors such as advanced age, age at menarche, female sex, and history of previous fractures. However, protective factors for bone mass loss in this population include body weight, hemoglobin, weekly heparin dose, and a history of parathyroidectomy [8]. ESRD patients with a low bone mass usually have a high incidence of fragility fractures [9]. The overall relative risk for hip fracture was 4.4 for dialysis patients compared with the general population [10]. It is important to periodically evaluate the BMD in these patients with dual-energy x-ray absorptiometry (DEXA). DEXA is reliable for the evaluation of the changes in BMD and bone mineral content at different sites [11].

Musculoskeletal disorders have an impact on the functional status of patients. HD patients have been reported to have elevated pain levels and impaired functional status. The Health Assessment Questionnaire (HAQ) is one of the first self-report functional status (disability) measures, and is used widely worldwide [12,13]. HAQ has been administered and validated in patients with a wide variety of chronic rheumatic diseases and it has also been used for patients with HIV/AIDS and chronic renal failure patients [14].

Objectives

This study was designed to determine the most common musculoskeletal system involvement in chronic HD patients and to show its effect on physical function (disability).

Patients and methods

Patients

A total number of 144 HD patients between 19 and 66 years of age, mean ± SD 47.5 ± 11.5 years, and disease duration between 1 and 21 years, mean ± SD 9.8 ± 4.6 years, were recruited during the period from January 2012 to January 2013. Dialysis was performed three times weekly using 3.5 mEq/l dialysate calcium. The duration of each dialysis was 4 h; protocols were not changed during the study.

Inclusion criteria

All chronic renal failure (CRF) patients included in this descriptive cross-sectional study were on HD in the Nephrology Unit in Zagazig University Hospitals for more than 12 months and all were older than 18 years.

This study was approved by the institutional ethics committee.

A written consent from all HD patients was obtained before entry into the study.

Exclusion criteria

Patients were excluded on the basis of the following criteria:

(a) Previous neurological disorders of the upper limbs or lower limb;
(b) Patients with rheumatic disorder on dialysis;
(c) Restricted joint motion because of skin lesions or contracture;
(d) Upper limb or lower limb arthroplasty, amputation, or joint fusion; surgery or trauma within the last 90 days;
(e) Severe psychiatric disorders.

Methods

All patients were subjected to a full assessment of medical history and clinical examination.

Demographic data were obtained, along with details of HD (frequency, duration, dialyzer type, and membrane), previous renal transplantation, duration of renal failure, parathyroidectomy, hand dominance, CTS, fistula localization, previous surgical intervention of joints, morning stiffness, and BMI. All the patients underwent a complete musculoskeletal examination by a rheumatologist.

Measurement of pain

Pain intensity was measured by a 100-mm pain visual analogue scale [15].

Measurement of physical disability

Assessment of disability was performed using the HAQ. There were eight groups of questions on activities of daily living included in HAQ (1–dressing and

grooming, 2–arising, 3–eating, 4–walking, 5–hygiene, 6–reach, 7–grip, and 8–common daily activities). The scores were determined using standard methods and the total score may range from 0 to 3 [14].

Laboratory findings

A blood sample was obtained to measure calcium (Ca), phosphorus (Ph), alkaline phosphatase (ALP), PTH, serum uric acid, serum albumin, serum iron, serum ferritin, and transferrin. The following are the normal laboratory parameter ranges: serum Ca 8.4–10.2 mg/dl, Ph 3.0–4.5 mg/dl, ALP 45–150 U/l, PTH 10–60 pg/ml, uric acid 2.5–8 mg/dl, albumin 11–48 mg/dl, iron 60–160 μg/dl, ferritin 15–200 ng/ml, and transferring 212–360 mg/dl.

Imaging

Plain radiography of symptomatic joints or parts of the body was performed.

Bone mineral density

DEXA was performed at the femoral neck (FN) and lumbar spine (LS). The T-score is a comparison of an individual's bone density with that of a healthy 30-year-old individual of the same sex. A T-score of −2.5 or lower signifies osteoporosis. A T-score of −1.0 to −2.5 signifies osteopenia, meaning below-normal bone density without full osteoporosis.

Statistical analysis

Quantitative variables were described using means, SDs, medians, interquartile ranges, and 95% confidence intervals for mean. Qualitative variables were described using proportion and percentage. The parametric Student's *t*-test was used to compare two groups. The Spearman rank correlation coefficient was used to assess the correlation between two quantitative variables. The level of significance in all tests was less than 0.05 ($P < 0.05$). Statistical analyses were carried out using SPSS version 14 for Windows (SPSS Inc., Chicago, Illinois, USA).

Results

The HD patients included in this study were 81 men (56.3%) and 63 women (43.7%). Their age ranged from 19 to 66 years (mean ± SD 47.5 ± 11.5 years), with disease duration ranging between 1 and 21 years (median 10 years), and the range of HAQ was 0.12–3 (mean ± SD 1.12 ± 0.68). Fifty-seven patients (39.6%) had no musculoskeletal manifestations and 87 patients (60.4%) had musculoskeletal manifestations. In this study, we found hypocalcemia in 44 patients (50.5%), hyperphosphatemia in 38 patients (43.6%), increased level of ALP in 66 patients (75.8%), and increased level of parathormone in 70 patients (80.4%) (Table 1).

The most common presenting symptom in our patients was joint pain (arthralgia) (25.3%), and the most common site was knee joint (56.3%), followed by back (43.7%), shoulder (32.2%), hip joint (18.4%), elbow (15.5%), wrist (14.1%), small joints (14.1%), cervical pain (10.7%), and finally ankle joint and foot pain (5.7%).

The results showed that osteopenia occurred in three patients (3.4%) and osteoporosis in nine patients (10.4%). T-score results were worse at LS than at FN (Table 2).

Results also indicated that the duration of HD showed a significant positive correlation with PTH ($r = 0.28$, $P < 0.024$) (Table 3).

The HAQ score showed a highly significant correlation with the PTH level, serum iron, serum ferritin, serum transferrin, (FN) DEXA, and (LS) DEXA.

Table 1 Laboratory findings among HD patients

Laboratory findings	Median or mean ± SD	Range
Intact parathyroid hormone (pg/ml)	642.2	9.9–3978
Calcium (mg/dl)	8.9 ± 1.13	6.5 ± 11.4
Serum phosphorus (mg/dl)	5.2 ± 1.6	2.1–9.7
Serum alkaline phosphatase (U/l)	193.5	119–454
Serum uric acid (mg/dl)	7.2 ± 1.98	5.8–8.6
Serum iron (μg/dl)	143	5–245
Serum ferritin (ng/ml)	831	20–7086.7
Serum transferrin (mg/dl)	84.0 ± 1.1	83–87
Serum albumin (g/dl)	3.8 ± 0.27	3.2–4.1

Table 2 Results of bone mass by DEXA among some HD patients with musculoskeletal manifestations

Regions	Median of T-score	Range of T-score
Lumbar spine DEXA	2.76	−4.6 to −3.6
Femoral neck DEXA	1.43	−3.4 to −2.1

DEXA, dual-energy x-ray absorptiometry; HD, hemodialysis.

Table 3 Correlation between duration of HD and laboratory findings in HD patients

Duration of HD	*r*	*P*
PTH	0.28	0.024*
Albumin	−0.42	0.02*
Transferrin	−1.00	0.00*
Serum Ca^{2+}	−0.09	0.47
Serum phosphorus	−0.04	0.77

HD, hemodialysis; PTH, parathyroid hormone; *$P < 0.05$ was statistically significant.

The results showed that there were highly significant differences in physical function and disability between HD patients with knee pain, hip pain, osteoarthritis (OA), osteoporosis, and those without pain, OA or osteoporosis (Table 4).

Table 4 HAQ in HD patients

Musculoskeletal manifestations	HAQ in HD patients		*t*	*P*
	Absence	Presence		
CTS	1.13 ± 0.73	1.01 ± 0.39	0.58	0.56
Shoulder pain	1.17 ± 0.64	1.80 ± 0.53	−2.87	0.02*
Elbow pain	1.1 ± 0.74	1.15 ± 0.58	−0.36	0.72
Wrist pain	1.21 ± 0.68	1.55 ± 0.31	−2.34	0.03*
Small joints pain	1.20 ± 0.66	1.59 ± 0.53	−2.6	0.01*
Knee pain	1.19 ± 0.59	1.6 ± 0.31	2.20	0.04*
Hip pain	1.06 ± 071	1.39 ± 0.43	−2.14	0.04*
Thoracolumbar pain	1.19 ± 0.74	1.03 ± .60	1.05	0.29
Cervical pain	1.13 ± 0.72	0.93 ± 0.22	1.64	0.11
OA	1.06 ± 0.71	1.4 ± 0.52	2.5	0.02*
Osteoporosis	0.95 ± 0.63	1.62 ± 0.01	−4.09	0.00*

CTS, carpal tunnel syndrome; HAQ, Health assessment questionnaire; HD, hemodialysis; OA, osteoarthritis; * = $P < 0.05$.

Table 5 Common musculoskeletal manifestations among HD patients

Musculoskeletal manifestations	*n* = 87 [*n* (%)]
Joint pain (arthralgia)	22 (25.3)
Osteoarthritis	15 (17.2)
Rotator cuff syndrome	3 (3.4)
Carpal tunnel syndrome	13 (14.9)
Tenosynovitis	6 (6.9)
Osteoporosis or osteopenia	12 (13.8)
Gout	3 (3.4)
Pseudo gout	1 (1.1)
Periarticular soft calcification	1 (1.1)
Fibromyalgia	1 (1.1)
Septic arthritis	1 (1.1)
Bone fracture	2 (2.3)
Muscle cramp	3 (3.4)
Bone cyst	4 (4.6)

HD, hemodialysis.

Discussion

In HD patients, all parts of the musculoskeletal system (bone, joint, muscle, tendon, and bursa) may be involved and most of the patients show evidence for more than one kind of musculoskeletal involvement [16].

Our results showed that among the 144 HD patients included in this study, 87 patients (60.4%) had musculoskeletal manifestations and 57 patients (39.6%) did not have musculoskeletal manifestations. The majority of the patients showed evidences for more than one kind of musculoskeletal manifestation. The most common presenting symptom in our patients was joint pain (arthralgia) (25.3%), and the most commonest site was knee joint (56.3%), followed by back (43.7%), shoulder (32.2%), hip joint (18.4%), elbow (15.5%), wrist (14.1%), small joints (14.1%), cervical pain (10.7%), and finally ankle joint and foot pain (5.7%). This result was in agreement with that of Kurer *et al.* [17], who reviewed 83 patients undergoing dialysis for at least 10 years. The most common complaint was severe joint pain in the absence of radiological changes of arthritis (41%), the shoulders usually being the most affected (33.7%), followed by knee pain (19%), hip pain (16%), wrist pain (12%), elbow pain (8%), ankle pain (8%), lumbosacral pain (7%), and finally cervical pain (6%). Also, the study of Chou *et al.* [18] reported that 20 HD patients had arthralgias, three had polyarthritis, and four had knee effusions.

In this study, the most common musculoskeletal manifestation among HD patients was joint pain (arthralgia) (25.3%), followed by OA (17.2%), CTS (14.9%), osteoporosis (13.8%), trigger finger and tenosynovitis (6.9%), bone cyst (4.6%), muscle cramp (3.4%), rotator cuff syndrome (3.4%), gout (3.4%), bone fracture (2.3%), and finally periarticular soft calcification, pseudo gout, septic arthritis, and fibromyalgia (1.1% each) (Table 5). The pathophysiology of these musculoskeletal manifestations is still poorly understood, but apatite crystal deposition, aluminum, or iron overload and the articular deposition of a new type of amyloid may play a role [19].

Our results showed that the frequency of OA among HD patients was high (17.2%) (Table 5). This was in agreement with Duncan *et al.* [20], who found that the prevalence of grade III or IV OA was three times greater in HD patients younger than 65 years old than in a control population.

The prevalence of CTS among HD patients with musculoskeletal manifestations was 14.9%. The previous result was consistent with that of Badry *et al.* [21], who reported that CTS is common in patients with end-stage renal failure on dialysis and about 13.3% were diagnosed with CTS depending on the second lumbrical-interosseous latency difference, which is a sensitive test to predict median neuropathy at wrist. Kurer *et al.* [17] reported that CTS had developed in 26 patients, and was bilateral in 14 of them; at operation, the presence of amyloid was confirmed. Busch *et al.* [22] also reported that the prevalence of CTS as a possible manifestation of dialysis-related amyloidosis is still high (31.7%) and the significant predictors of CTS were age, female sex, serum β2-microglobulin, and total protein. This was in

agreement with the study of Kopec *et al.* [23] who showed that the incidence of CTS among patients treated for a long period of HD (20–30 years) was 10.4% on the basis of signs and physical symptoms, and nerve conduction. They also found that the duration of dialysis treatment was a statistically significant risk factor for the development of CTS (16.05 vs. 4.51 years; $P < 0.0001$). However, no statistically significant differences were found when comparing CTS incidence by sex or between the development of CTS requiring surgical release intervention and location of the arteriovenous fistula [23].

This study showed that the prevalence of osteoporosis among HD patients with musculoskeletal manifestation was 13.8%. This was not in agreement with Vachtenheim *et al.* [24], who observed that the prevalence of osteoporosis in HD patients was 12.9%.

In this study, we observed that bone cyst was found in 4.6% of HD patients depending on bone radiographic examination. The characteristic cystic radiolucency (CRL) was observed commonly at pelvis bones, hip bones, and carpal bones. This was in agreement with the study of Maruyama [25], who found that the grade and frequency of characteristic CRL and destructive spondylarthropathy of cervical vertebrae also increased in accordance with age and HD duration and CRL of the carpal bone; shoulder CRL was observed in 39.7%, hip CRL in 25.8%, and destructive spondylarthropathy in 14.3% of cases, respectively; these frequencies increased with an increase in HD duration.

Muscle cramp occurred in 3.4% and bone fracture in 2.3% of HD patients with musculoskeletal manifestations. This was in agreement with Chou *et al.* [18], who reported that muscle cramps were observed in 24 HD patients, multiple fractures in one patient, symmetrical distal neuropathy in 18 patients, and CTS in nine patients.

Tendonitis, particularly trigger finger, occurred in 6.9% of HD patients with musculoskeletal manifestations. Rillo *et al.* [26] reported that tendonitis and ligamentous hyperlaxity were present in 29 patients (49% with patellar tendon elongation, 51% with articular hypermobility). Similarly, Kurer *et al.* [17] reported that other manifestations of amyloidosis included trigger finger, flexor tendon contracture, and spontaneous tendon rupture.

It has been shown that the prevalence of crystalline arthropathy including gout and pseudogout was 3.4 and 1.1%, respectively. The incidence of gout in dialysis patients is believed to be rare. A study from Japan showed a 2.8% frequency of gout after the initiation of renal replacement therapy [27]. Vachtenheim *et al.* [24] reported that crystalline arthropathy with typical attacks of gout was found in only 11 patients (5%). The United States Renal Data System (USRDS) database from 2000 to 2004 reported a prevalence of 5.9% for patients with a history of gout-related nephrolithiasis or obstruction in the ESRD program [28]. The reasons for these disparities are not clear, but may be related to the larger number of patients sampled or differences in lifestyle/diet. It is also likely that a significant number of patients with ESRD had a predialysis episode of gout that could not be identified because of the inherent limitations of an observational study. This would serve to overestimate the actual incidence of gout among patients in the USRDS.

Shoulder pain was recorded in 32.2% of patients, and about 3.4% of these patients had rotator cuff syndrome (Table 5). This was not in agreement with Bernageau *et al.* [28] who reported spontaneous shoulder pain in 24 HD patients (20 patients had bursitis and 21 patients had glenohumeral synovitis).

Painful shoulder in patients on chronic hemodialyis is most often associated with dialysis arthropathy or accumulation of deposits containing modified fibrils of β2-microglobulin, especially in bones and joints, because of insufficient elimination during the therapy. A study of Barisić *et al.* [29] showed that the plasmatic level of β2-microglobulin is strongly linked to painful shoulder in dialyzed patients, as well as C-reactive protein as a sign of acute inflammation. They also reported that the previously mentioned morphologic parameters were associated with histologically proved amyloidosis in patients on long-term dialysis of more than 10 years [30]. Bilateral shoulder/upper limb pain could be attributed to subdiaphragmatic irritation with dialysate fluid. The study of Ardalan *et al.* [30] found that 5% of incident PD patients developed infusion-related pain. The phrenic nerve (C3, C4, and C5) is the motor nerve of the diaphragm and also contains many sensory and sympathetic fibers. Dialysate fluid-induced irritation of the diaphragmatic peritoneum may result in a referred pain in the distribution of the C5 nerve root along the musculocutaneous, axillary, radial, and median nerves [31].

We recorded one case of septic arthritis (1.1%) (Table 2). This was not in agreement with a multicenter retrospective review on HD patients from 1999 to 2005. All patients had positive synovial fluid and blood cultures. The organisms isolated were all skin commensals, being staphylococcal in 13 patients and streptococcal in two patients [32]. Diabetes is the number one systemic risk factor identified in general septic arthritis and for sepsis in general,

possibly because of sustained hyperglycemia retarding neutrophil chemotaxis [33].

BMD testing showed osteopenia in three patients (3.4%) and osteoporosis in nine patients (10.4%). BMD T-scores at the FN ranged from −3.4 to −2.1, whereas BMD T-scores at LS ranged from −4.6 to −3.6 (Table 2). T-score results were worse at LS than at FN. This was not in agreement with the study of Sit *et al.* [34], who reported that the T-score at the FN was osteoporotic in 10% of patients (n = 7) , osteopenic in 54.3% (n = 38) , and normal in 35.7% (n = 25). However, the T-score results of LS were 47.1% (n = 33) osteoporotic, 35.7% (n = 25) osteopenic, and 17.1% (n = 12) normal. A similar study reported osteopenia in 16 patients (37.2%) and osteoporosis in seven patients (16.3%) [35].

In this study, we reported hypocalcemia in 44 patients (50.5%), hyperphosphatemia in 38 patients (43.6%), increased level of ALP in 66 patients (75.8%), and increased parathormone in 70 patients (80.4%) (Table 1). Similarly, Suwan [36] reported the level of hyperparathyroidism in 29.48% of continuous ambulatory PD patients. He also found significantly lower levels of serum calcium (P = 0.037) and serum phosphate (P = 0.016) and significantly higher serum ALP concentrations (P = 0.029). Billa *et al.* [37] also reported a high prevalence of hyperparathyroidism in a PD population and the PTH in 47% of patients was more than three times the normal, mean 54.6 ± 35.4 pmol/l.

Patients with CKD almost always develop secondary hyperplasia of the parathyroid glands, resulting in elevated blood levels of parathyroid hormone (PTH). This abnormality is due to the hypocalcemia that develops during the course of kidney disease and/or to a deficiency of 1,25-dihydroxycholecalciferol [l, 25(OH)2D3] that may directly affect the function of the parathyroid glands. With progressive loss of kidney function, a decrease in the number of vitamin D receptors (VDR) and calcium-sensing receptors (CaR) in the parathyroid glands occurs, rendering them more resistant to the action of vitamin D and calcium. In addition, the development of hyperphosphatemia directly affects the function and the growth of the parathyroid glands. These events will allow secondary hyperparathyroidism to worsen [38].

At least 3 hypotheses have been proposed to explain the pathogenesis of the hypocalcemia:

(a) Phosphate retention,
(b) Skeletal resistance to the calcemic action of PTH, and
(c) Altered vitamin D metabolism. Together, these factors form a unified and integrated explanation for the hypocalcemia of CKD, and provide a framework for the management of altered mineral and bone metabolism of CKD [39].

It is evident; that phosphate retention and hyperphosphatemia can provoke secondary hyperparathyroidism in the absence or presence of impaired kidney function. Consequently, because secondary hyperparathyroidism occurs early in the course of CKD, hyperphosphatemia would be expected to develop at an early stage of reduced kidney function [40].

It has been proven that secondary hyperparathyroidism is associated with poor self-reported physical function in HD patients. There were significant correlations between HAQ and PTH (P < 0.02) (Table 6). Malindretos *et al.* [41] found that in HD patients, secondary hyperparathyroidism appears to be associated with worse pain component scores (P = 0.036) and physical component scores (P = 0.029).

In this work, upper extremity disability was noted in HD patients, particularly hand dysfunction. The results showed that patients with shoulder pain, wrist pain, and pain of the small hand joints had significantly higher HAQ scores than those without (P < 0.02*, P < 0.03*, P < 0.01*), respectively (Table 4). A study of Hurton *et al.* [42] showed that the mean Disabilities of the Arm, Shoulder, and Hand score in HD patients was 31 ± 22 points, indicating markedly greater disability than in a normal population. This was in agreement with Limaye *et al.* [43] who assessed hand function in HD patients using the Sollerman test of hand grip function, and the median Sollerman score was 77,

Table 6 Correlation between HAQ and laboratory findings and DEXA among HD

HAQ	*r*	*P*
Age	0.03	0.82
Disease duration	0.02	0.85
PTH	−0.31	0.02*
Serum calcium	0.22	0.09
Serum phosphorus	−0.21	0.12
Serum ALP	−0.29	0.53
Serum iron	−0.48	0.00*
Serum ferritin	−0.37	0.03*
Serum transferrin	−1.0	0.00*
Serum albumin	0.14	0.48
Serum ALT	0.34	0.08
Femur neck DEXA	−0.76	0.00*
Lumbar spine DEXA	−0.818	0.00*

ALP, alkaline phosphatase; ALT, alanine transaminase; DEXA, dual energy x-ray absorptiometry; HAQ, Health Assessment Questionnaire; HD, hemodialysis; PTH, parathyroid hormone; S, serum; * = P < 0.05.

with 19/35 patients (54%) receiving HD having a score below the lower normal value of 78–80. The log Sollerman score correlated significantly with the HAQ score (r_s = −0.66, P < 0.00005) and duration of HD (r_s = −0.39, P < 0.05). Similar results of impaired hand function in HD patients were observed in the study of Celal Bayar University Medical School Hospital [44]. Impaired hand function in HD patients often has complex pathogenic mechanisms. The accumulation and deposition of β2-microglobulin (polypeptide) in musculoskeletal structures in HD patients leads to amyloidosis and consequently functional impairments or disability [45].

The results of our study showed that there were highly significant differences in physical function and disability using HAQ between HD patients with knee pain, hip pain, OA, osteoporosis, and those without (P < 0.04*, 0.04*, 0.02*, and 0.00*, respectively).

Conclusion

Musculoskeletal system involvement remains a common problem limiting the physical function of renal failure patients, particularly those treated with long-term maintenance dialysis, and requires more attention in its prevention and treatment by the physicians.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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