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Elbow Pain Related with Vascular Access Area: An Important but Frequently Overlooked Risk Factor for Upper Extremity Disability in Patients with End Stage Renal Disease

Dolor de codo relacionado con el área de acceso vascular: un factor de riesgo importante pero frecuentemente ignorado como causa de discapacidad de las extremidades superiores en pacientes con enfermedad renal en etapa terminal

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ABSTRACT

Objective: This study aimed to assess the presence of elbow pain and its relationship with vascular access site for hemodialysis in end-stage renal disease patients. **Methods:** One-hundred and nine chronic end-stage renal disease patients over 18 years of age undergoing hemodialysis treatment were enrolled in the study. Patients who had undergone surgery of the upper extremity in the last three months and patients with cancer, chronic hearing loss, or neurologic diseases were excluded. Sociodemographic features were evaluated. The Beck Depression Inventory, the Nottingham Health Profile, the Disabilities of the Arm, Shoulder and Hand Score, and the Visual Analogue Scale were administered to all patients. **Results:** One-hundred and nine patients (38 women, 71 men) participated in the study. The mean age of the patients was 62.22 ± 11.64. The patients were grouped based on the presence of elbow pain into Group 1 (elbow pain positive, n=30) and Group 2 (elbow pain negative, n=79). There was a statistically significant difference between the groups in terms of vascular access site and elbow pain site (p=0.002). In addition, the patients with elbow pain were mostly women, and this result was statistically significant (p<0.05). **Conclusions:** According to the results of this study, there may be a relationship between elbow pain and hemodialysis vascular site.

Keywords: Elbow, end stage renal disease, hemodialysis, musculoskeletal pain, pain

RESUMEN

Objetivo: Este estudio tuvo como objetivo evaluar la presencia de dolor en el codo y su relación con el sitio del acceso vascular para hemodiálisis en pacientes con enfermedad renal terminal. **Métodos**: Participaron del estudio 109 pacientes mayores de 18 años con enfermedad renal crónica terminal en tratamiento de hemodiálisis. Se excluyeron los pacientes intervenidos quirúrgicamente en la extremidad superior en los últimos tres meses y los pacientes con cáncer, hipoacusia crónica o enfermedades neurológicas. Se evaluaron las características sociodemográficas. A todos los pacientes se les administró el Inventario de Depresión de Beck, el Perfil de Salud de Nottingham, la Puntuación de Discapacidades del Brazo, el Hombro y la Mano, y la Escala Visual Analógica. **Resultados**: Ciento nueve pacientes (38 mujeres, 71 hombres) participaron en el estudio. La edad media de los pacientes fue de 62,22 ± 11,64. Los pacientes se agruparon en función de la presencia de dolor en el codo en dos grupos: el Grupo 1 (dolor en el codo positivo, n=30) y el Grupo 2 (dolor

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en el codo negativo, n=79). Hubo una diferencia estadísticamente significativa entre los grupos en cuanto al sitio de acceso vascular y el sitio del dolor en el codo (p=0,002). Además, los pacientes con dolor en el codo eran en su mayoría mujeres, y este resultado fue estadísticamente significativo (p<0,05). **Conclusiones**: Según los resultados de este estudio, puede existir una relación entre el dolor del codo y el sitio vascular de hemodiálisis.
Palabras clave: Codo, enfermedad renal terminal, hemodiálisis, dolor musculoesquelético, dolor

INTRODUCTION

Chronic renal disease is defined as impairment of renal function for three months. Based on the result of the estimated glomerular filtration rate (eGFR), the renal disease stage can be determined, and end-stage renal disease is the last stage when eGFR is <15 ml/min/1,73 m^2. Hemodialysis is necessary to replace renal function ultrafiltration for end-stage renal disease patients. [1,2]

Arteriovenous fistula (AVF) is the first choice for vascular access in hemodialysis patients. Forearm (radiocephalic or distal AVF), elbow (brachiocephalic or proximal AVF), and arm (brachial-basilic AVF with transposition or proximal AVF) are preferred for AVF locations. The gold standard for vascular access is AVF on the wrist. Arteriovenous grafts are preferred after there was a problem with native vessels. Central venous catheterization (CVC) is another option when urgent or emergent hemodialysis is required at the beginning of renal hemodialysis or when a vascular access site becomes dysfunctional. [3-5] The internal jugular vein is the first choice for CVC approaches, and the second choice is the femoral vein. Another option is the subclavian vein, but a proximal or terminal AVF on the same side should be avoided. [5]

The ulnohumeral, radiohumeral, and proximal radioulnar articulations compose the elbow joint. The osseous surfaces of the elbow are the origin and insertion of many muscles that provide flexion, extension, pronation, and supination of the elbow joint. [6] Due to this complex anatomy of the elbow joint, evaluation of elbow pain may be difficult. The history of elbow pain provides important clues for diagnosis. Based on the anatomic location of the elbow, the etiologies of elbow pain are classified as anterior, posterior, medial, and lateral. Anterior elbow pain etiologies include anterior capsule strain, biceps tendinopathy, gout, intra-articular loose body, osteoarthritis, pronator syndrome, and rheumatoid arthritis. Posterior elbow pain etiologies include olecranon bursitis, olecranon stress fracture, osteoarthritis, and posterior impingement triceps tendinopathy. Medial elbow pain etiologies include cubital tunnel syndrome, medial epicondylitis, ulnar collateral ligament injury, and valgus extension overload syndrome. Lateral elbow pain etiologies include lateral epicondylitis, osteochondral defect, plica, posterolateral rotatory instability, and posterior interosseous nerve syndrome. [7] One of the most common causes of elbow pain is lateral epicondylitis; it is seen in 1%–3% of the general population. [8] Repeated overuse of the extensor carpi radialis brevis tendon causes lateral epicondylitis. [9] The other most common lesion of the elbow is medial epicondylitis, which is encountered in approximately 1% of people annually. [10] It occurs because of repetitive flexion and pronation movements. [11] The patient's occupation and physical activities are important considerations when evaluating elbow pain. [7]

Pain is a common problem in end-stage renal disease. [12] Chronic pain was identified in 50% of hemodialysis patients, and musculoskeletal pain was detected as the most common problem (63.1%). [13]

There are no studies in the literature about the presence of elbow pain and the relationship between elbow pain and vascular access sites in hemodialysis patients. Thus, the aim of this study was to evaluate the presence of elbow pain in end-stage renal disease patients undergoing hemodialysis treatment and to identify its relationship with vascular access location.

METHODS

The study was conducted in accordance with the Declaration of Helsinki, and it was approved by the University Faculty of Medicine Ethics Committee (Decision no: 2019.29.02.13). It has been registered on ClinicalTrials.gov with the registration number. One hundred and nine end-stage renal disease patients who were undergoing hemodialysis treatment were enrolled in the study. All patients were receiving bicarbonate hemodialysis three times a week for a duration of four to five hours each. The inclusion

criterion was being over 18 years old. The exclusion criteria were any surgical operation of the upper extremity in the last three months and the presence of diseases, such as cancer, chronic hearing loss, and neurologic diseases, that could influence the interview.

Sociodemographic features including age, gender, marital status, duration of dialysis, education level, comorbid diseases, vascular access location, and hand dominance were analyzed. The Beck Depression Inventory (BDI) and the Nottingham Health Profile (NHP) were administered to all patients to evaluate depressive symptoms and health-related quality of life. All of the patients were asked if they had elbow pain. They were also assessed with the Quick Disabilities of the Arm, Shoulder and Hand Score (Q-DASH) and the Visual Analogue Scale (VAS). The VAS was defined as pain during rest, activity, at night, and during the last week.

The Beck Depression Inventory (BDI)

The BDI has 21 items that describe symptoms of depression. The questionnaire is in a multiple-choice format, and each item has a four-point scale variable from 0 (absent) to 3 (severe). The minimum score is 0 and the maximum score is 63. The BDI was translated into Turkish, and reliability and validity findings for Turkish people were accepted by Hisli in 1988. [14]

The Nottingham Health Profile (NHP)

The NHP has two parts. The first part of the NHP has six domains that include pain, emotional reaction, sleep, social isolation, physical abilities, and energy level. The second part of the NHP assesses the presence of difficulties with performing daily activities. The NHP was adapted into Turkish in 2000, and the study results suggest it is useful for clinical studies of rehabilitation. [15]

The Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH)

The Q-DASH has 11 items (scored 1–5) and evaluates function and pain regarding upper extremity musculoskeletal disorders. The Q-DASH has three items about symptoms and eight items for function and can be used for various upper extremity problems. [16,17]

The Visual Analogue Scale (VAS)

Pain was evaluated with the VAS. [18] Pain intensity was categorized as pain during rest (VAS-r), activity (VAS-a), at night (VAS-n), and during the last week (VAS-w).

Statistical analysis

Continuous variables were expressed as mean ± standard deviation and median (minimum–maximum), whereas categorical data were numbers and percentages. Normality analyses were performed with the Kolmogorov-Smirnov goodness-of-fit test in the cross-group analysis of continuous variables. The independent samples t-test was used in the evaluation of the groups that fit the normal distribution of continuous variables. Cross-group comparisons of variables not eligible for normal distribution were performed with the Mann-Whitney U test. The chi-square test (Fisher's exact test when necessary) was used in the comparison of categorical data. The analyses were performed with the Statistical Package for the Social Sciences (SPSS) software program version 24.0 (IBM Corporation, Armonk, NY, USA). The statistical significance level was set at $p<0.05$.

RESULTS

A total of 109 hemodialysis patients, including 38 women (34.9%) and 71 men (65.1%), were enrolled in the study. The mean age of the patients was 62.22 ± 11.64. The patients were grouped based on the presence of elbow pain into Group 1 (elbow pain positive, n=30) and Group 2 (elbow pain negative, n=79). The number of women in Group 1 (63.3%) was found to be statistically significantly higher than in Group 2 (24.1%) ($p<0.001$). However, there were no statistically significant differences between the two groups in terms of age, education level, marital status, diabetes mellitus, hypertension, hyperlipidemia, and hypothyroidism ($p>0.05$). Comparisons of the demographic and some clinical features of the hemodialysis patients by the group are presented in **Table 1**. The mean values of Q-DASH, NHP, and BDI and the median values of VAS-r, VAS-n, VAS-a, and VAS-w were found to be higher in Group 1 than in Group 2, and the differences were statistically significant ($p<0.05$). There were no statistically significant differences between the two groups

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in terms of vascular access location, vascular access site, hand dominance, and duration of hemodialysis (p>0.05). A comparison of the demographic and some clinical features among the groups is shown in **Table 2**.

When the vascular access site and elbow pain site were compared, there was a statistically significant difference between the groups (p=0.002). The pain was on the left side in the majority of patients with elbow pain, also the vascular access site of the patients with right elbow pain was on the right side. Cross-classification tables between the vascular access site and elbow pain site are shown in **Table 3**.

The Q-DASH, BDI, VAS-r, VAS-n, VAS-a, and VAS-w scores were statistically significantly higher in patients with forearm vascular access than in patients with wrist vascular access (p<0.05).

Table 1. Comparison of the demographic and some clinical features of HD patients by groups

	Group 1 (pain positive) (n=30)	Group 2 (pain negative) (n=79)	Total (n=109)	*p*
Age (mean ± SD)	64.33±10.85	61.41 ± 11,89	62.22 ± 11,64	0.245*
Gender (n, %)				
Female	**19 (63.3%)**	19 (24.1%)	38 (34.9%)	**<0.001****
Male	11 (36.7%)	60 (75.9%)	71 (65.1%)	
Educational status (n, %)				
Primary school dropout	3 (10.0%)	8 (10.1%)	11 (10.1%)	0.211**
Primary school	24 (80.0%)	53 (67.1%)	77 (70.6%)	
Secondary school	1 (3.3%)	7 (8.9%)	8 (7.3%)	
High school	0 (0.0%)	9 (11.4%)	9 (8.3%)	
University	2 (6.7%)	2 (2.5%)	4 (3.7%)	
Marital status (n, %)				
Single	1 (3.3%)	3 (3.8%)	4 (3.7%)	0.959**
Married	23 (76.7%)	62 (78.5%)	85 (78.0%)	
Divorced/Widowed	6 (20.0%)	14 (17.7%)	20 (18.3%)	
Diabetes mellitus (n, %)				
No	19 (63.3%)	52 (65.8%)	71 (65.1%)	0.808**
Yes	11 (36.7%)	27 (34.2%)	38 (34.9%)	
Hypertension (n, %)				
No	13 (43.3%)	35 (44.3%)	48 (44.0%)	0.927**
Yes	17 (56.7%)	44 (55.7%)	61 (56.0%)	
Hyperlipidemia (n, %)				
No	29 (96.7%)	76 (96.2%)	105 (96.3%)	1.000**[a]
Yes	1 (3.3%)	3 (3.8%)	4 (3.7%)	
Hypothyroidism (n, %)				
No	29 (96.7%)	78 (98.7%)	107 (98.2%)	0.477**[a]
Yes	1 (3.3%)	1 (1.3%)	2 (1.8%)	
Total	30 (100.0%)	79 (100.0%)	109 (100.0%)	

* T Test

** Chi-square Test ([a]Fisher's exact test)

Q-DASH, Quick- Disabilities of Arm, Shoulder and Hand; SD, Standard Deviation; VAS-r, Visual Analogue Scale for pain during rest; VAS-n, Visual Analogue Scale for pain during night; VAS-a, Visual Analogue Scale for pain during activity; VAS-w, Visual Analogue Scale for pain at last week;; NHP, Nottingham Health Profile; BDI, Beck Depression Inventory

Table 2. Comparison of the demographic and some clinical features among groups

	Group 1 (pain positive) (n=30)	Group 2 (pain negative) (n=79)	Total (n=109)	*p*
Vascular access location (n, %)				
Wrist	6 (20.0%)	21 (26.6%)	27 (24.8%)	0.621*[a]
Forearm	24 (80.0%)	58 (73.4%)	82 (75.2%)	
Vascular access site (n, %)				
Right	5 (16.7%)	23 (29.1%)	28 (25.7%)	0.226*[a]
Left	25 (83.3%)	56 (70.9%)	81 (74.3%)	
Hand dominancy (n, %)				
Right	26 (86.7%)	66 (83.5%)	92 (84.4%)	0.776*[a]
Left	4 (13.3%)	13 (16.5%)	17 (15.6%)	
Duration of hemodialysis (months) [median (min-max)]	32 (3-204)	36 (4-312)	36 (3-312)	0.684**
QDASH (mean ± SD)	65.82±21.72	32.50±28.59	41.67±30.67	**<0.001****
VAS-r [median (min-max)]	4 (0-10)	0 (0-8)	1 (0-10)	**<0.001****
VAS-n [median (min-max)]	4.5 (0-10)	0 (0-9)	1 (0-10)	**<0.001****
VAS-a [median (min-max)]	5 (0-10)	1 (0-10)	3 (0-10)	**<0.001****
VAS-w [median (min-max)]	5 (0-10)	1 (0-10)	3 (0-10)	**<0.001****
NHP (mean ± SD) 166.60±66.26 117.39±85.76 130.93±83.53 **0.002*****				
BDI (mean ± SD)	18.93±10.56	12.62±9.71	14.35±10.30	**0.004*****

* Chi-square Test ([a]Fisher's exact test)
** Mann Whitney U Test
*** T Test

Q-DASH, Quick- Disabilities of Arm, Shoulder and Hand; SD, Standard Deviation; VAS-r, Visual Analogue Scale for pain during rest; VAS-n, Visual Analogue Scale for pain during night; VAS-a, Visual Analogue Scale for pain during activity; VAS-w, Visual Analogue Scale for pain at last week; NHP, Nottingham Health Profile; BDI, Beck Depression Inventory

Table 3. Cross tables between vascular access site and elbow pain site

	Vascular Access Site		Total	*p*
Elbow pain site	**Right**	**Left**		
Right	5 (100.0%)	5 (20.0%)	10 (33.3%)	
Left	0 (0.0%)	20 (80.0%)	20 (66.7%)	**0.002***[a]
Total	5 (100.0%)	25 (100.0%)	30 (100.0%)	

* Chi-square Test ([a]Fisher's exact test)

DISCUSSION

The presence of elbow pain and the relationship between vascular access site and elbow pain in hemodialysis patients were evaluated in this study. In the general population, elbow pain is caused by multiple pathologies, including tendinopathies, osteoarthritis, medial epicondylitis, lateral epicondylitis, and compressive neuropathies[7]. However, there are no studies about elbow pain in chronic renal disease patients in the literature. In this current study, the majority of patients with elbow pain were women. It was seen that the patients with elbow pain had much significantly poorer functional, pain, and daily living scores. Also, the

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BDI score was found to be significantly lower in patients with elbow pain. The results of this study suggested that there may be a relationship between elbow pain and hemodialysis vascular site.

Pain caused by musculoskeletal diseases is frequently seen in chronic renal disease patients and end-stage renal disease patients. Caravaca et al. conducted a study that included 1169 patients (mean age 65±15 years, 54% male) with chronic renal disease stage 4–5 pre-dialysis. Thirty-eight percent of the patients had complaints of chronic musculoskeletal pain. [19] Also, studies have shown that pain is an important issue for patients with end-stage renal disease, and the prevalence of pain is higher in hemodialysis patients. Davison defined pain prevalence in a study of 205 hemodialysis patients and the study gave evidence that 50% of hemodialysis patients have pain that affects their health-related quality of life. The same study also demonstrated that musculoskeletal pain was the most common type of pain (63.1%). [13]

Also, other researchers have confirmed that musculoskeletal problems are seen frequently in hemodialysis patients. In a study of 89 hemodialysis patients, Hage et al. reported that the frequency of musculoskeletal symptoms, such as paresthesia, joint swelling, pain, and cramps, was 76.4% and the pain was the most common symptom (44.9%). The musculoskeletal problems were localized at spine (32.6%), shoulder (29.2%), hand (29.2%), knee (24.7%), hip (16.9%), foot (7.9%), and elbow (2.2%)[20]. However another study consisted 200 hemodialysis patients showed the complaint at the elbow was more frequently, as 8.5% (right elbow) and other musculoskeletal symptoms were in the knee (51.5%), the ankle (48%), thigh (35%) and right shoulder (8.5%) [21].

Gender, age, comorbidities, and duration of hemodialysis are the main risk factors for musculoskeletal pain in hemodialysis patients. Caravaca et al. reported that gender is an important feature of musculoskeletal pain in chronic renal diseases. Thirty-eight percent of the 1169 patients in the study had musculoskeletal pain, and 59% of the patients in the pain group were women.[19] There are various hypotheses regarding the reasons why pain is more common in women than in men. One of the hypotheses defines as peripheral and central perception systems may be affected by having greater sensitivity to pain in women.[22]

The preclinical studies have suggested that after diseases or injuries many metabolites, cytokines, and growth factors occur with the infiltration of immune cells. These processes are managed by different gene expression patterns in women and men. The increased signal from muscle afferents in the spinal cord is modulated by microglia in men whereas T cells perform the task in women. Pain perception in the brain may be more influenced by gender-specific psychological and emotional factors, leading to different pain sensations in men versus women.[23]

The duration of hemodialysis is another important issue for musculoskeletal pain. A cross-sectional study in hemodialysis patients showed that patients with musculoskeletal symptoms had longer dialysis periods than those without musculoskeletal symptoms.[20] It is known that there are many complications of end-stage renal disease with hemodialysis therapy consisting of cardiovascular, anemia, pulmonary complications, musculoskeletal, neurologic manifestations, cutaneous manifestations, and ımmunological abnormalities.[24]

The frequency and severity of the complications increase with the duration of chronic renal disease. Dialysis-related musculoskeletal problems include compression syndromes, articular, bone, and vertebral abnormalities, chronic kidney disease mineral and bone disorders are important difficulties for end-stage chronic renal disease patients. [25] Metabolic bone disorder in chronic renal diseases is manifested by abnormalities of calcium phosphorus, parathyroid hormone (PTH), and vitamin D metabolism, abnormalities in bone turnover, mineralization, and vascular or soft tissue calcification. [26] Also, a correlation between biochemical parameters like hyperuricemia and calcium x phosphate product levels with the presence of musculoskeletal pain was detected in early and end-stage chronic renal disease patients. [27]

In the current study, 109 hemodialysis patients participated. The patients were divided into two groups according to the presence of elbow pain, and elbow pain was found in 30 patients (26.7%). There was a statistically significant difference between groups in terms of gender, and the majority of patients with elbow pain were women ($p<0.05$). In the general population, most studies have shown that chronic widespread pain due to musculoskeletal disorders is seen more frequently

in women than in men, and it is also related to age. [28] In this study, the mean age of the patients with elbow pain was higher than the patients without elbow pain, but there was no statistically significant difference between groups in terms of age. Hus et al. reported that 53.3% of patients had chronic musculoskeletal pain in a study of 456 patients with chronic renal diseases. The mean age of the patients with chronic musculoskeletal pain was higher than the patients without chronic muscle pain, but just like in the current study, there was no statistically significant difference. [27] Similar results have been reported in other studies about the general population. The prevalence of musculoskeletal pain rises up to age 55–64 years for men and 65–69 years for women. [29]

Multiple studies have shown that psychosocial factors, such as low education level, anxiety, depression, lack of family support, and being divorced or widowed, are associated with musculoskeletal pain. [30-32] In the current study, although there were no statistically significant differences, the number of married patients was lower in the group that included patients with elbow pain, and the education level was higher in the group that included patients without elbow pain. Similarly, another study showed that physical factors, such as comorbidities and obesity, marital status (separated, divorced, or widowed), psychological factors, and social factors (education and employment) are associated with pain more commonly in women. [19]

In the current study, the prevalence of diabetes mellitus was higher in the group that included patients with elbow pain. However, there was no statistically significant difference between the groups. The findings of a study about hemodialysis patients by Hage et al. may support this result. Diabetes mellitus was detected more often in patients with musculoskeletal pain, but they did not find a statistically significant difference between patients with musculoskeletal pain and those without musculoskeletal pain. [20]

It is well-known that diabetes mellitus causes nerve damage and neuropathic pain. [32] Patients with elbow pain may be more sensitive to pain due to diabetes mellitus, and there may be neuropathies caused by diabetes mellitus as well as chronic renal disease. This issue may be a pain factor; however, neuropathy was not evaluated in this study.

In this study, the mean BDI result of the patients with elbow pain was 18.93±10.56, which can be interpreted as "borderline clinical depression". On the other hand, the mean BDI result of the patients without elbow pain was 12.62±9.71, which is considered "mild mood disturbance". The comparison of these results was statistically significant ($p<0.005$). Similarly, the NHP scores, Q-DASH, VAS-r, VAS-n, VAS-a, and VAS-w were higher in the patients with elbow pain than in the patients without elbow pain, and the differences in these results between groups were statistically significant ($p<0.005$). These results suggest that pain is important for a tendency to depression and that pain affects daily activities. Many studies have suggested that depression is the most common psychiatric disorder, and it is seen in approximately 25% of hemodialysis patients. [33] Also, pain is a predisposing factor for depression according to pain severity; daily activity impairment and functional limitations increase, and there is a decrease in health-related quality of life. [34]

In the current study, a statistically significant difference was determined in the comparison between vascular access site and elbow pain ($p<0.05$). This result suggests that there can be a relationship between vascular access sites and elbow pain. The majority of patients with left elbow pain had vascular access on the left side, and the patients with right elbow pain had vascular access on the right site. The patients in this study mostly had right-hand dominance. The reason for this result could be that patients avoid using the extremity and exercise on the vascular access site. According to guidelines, to avoid affecting the quality of life, the non-dominant arm is preferred for vascular access in as many cases as possible. [35]

Another important point in this study is that pain and daily living activities assessment tool scores were affected according to the location of vascular access, and the scores were statistically significantly higher in patients with elbow pain who had forearm vascular access than in patients with elbow pain who had wrist vascular access ($p<0.05$). This outcome may be due to poor movement at the elbow joint and that forearm access may restrict elbow motion and function, so avoiding exercises has an effect on elbow pain more than wrist vascular access.

The main limitation of this study is its relatively small sample size; therefore, a comparison of the type of vascular access as wrist or forearm for elbow

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pain presence could not be performed. Another limitation is that elbow pain etiologies and physical examination results could not be evaluated.

CONCLUSION

As has been mentioned, this is the first study to evaluate elbow pain presence in end-stage renal disease patients. The current results demonstrate that the presence of elbow pain may be related to the hemodialysis vascular access site**.** Further study is required with larger patient groups to investigate the relationship between elbow pain and vascular access site of the upper extremity.

Highlights

1. 109 patients with chronic end-stage renal disease were included in the study
2. The Beck Depression Inventory, the Nottingham Health Profile, the Disabilities of the Arm, Shoulder and Hand Score, and the Visual Analogue Scale were applied to the patients.
3. The patients were grouped based on the presence of elbow pain.
4. There may be a relationship between elbow pain and hemodialysis vascular site.

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