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Posture Analysis and Presence of Sacroiliac Joint Dysfunction in Patients with Chronic Lower Extremity Edema

Kronik Alt Ekstremite Ödemi Olan Hastalarda Sakroiliyak Eklem Disfonksiyonu Varlığı ve Postür Analizi

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Abstract

Aim: Chronic lower extremity edema has been associated with postural impairment, sacroiliac joint dysfunction (SIJD), and abnormal gait. Lymphedema and lipedema are important causes of chronic lower extremity edema. This study aimed to detect the presence of SIJD and postural disorders in patients with lower extremity edema and the relationship between them.

Material and Method: This study is a comparative prospective cross-sectional study. Fifty-three patients with lower extremity edema and 53 healthy subjects were included in the study. Pain provocation tests were used to determine SIJD. Postural analysis was conducted with PostureScreen® Mobile 11.2 (PostureCo, Inc., Trinity, FL) software. The life quality of participants was determined by the Lymphedema Quality of Life (LYMQOL) scale. The functional status of the patients was determined by the Oswestry Disability Index and Lower Extremity Functional Scale.

Results: SIJD (18.9%) was more common in the edema group. There was a positive correlation between volume differences, percentages, and the presence of SIJD. We found deviations in the head, shoulder, and hip angulations in the edema group. Q angle and lateral shoulder angulation were significantly higher in patients with SIJD in the edema group. In the edema group, LYMQOL-leg total score was higher in patients with SIJD.

Conclusion: Chronic lower extremity edema was found to be associated with postural deviations and SIJD. Besides edema control, postural disorders and SIJD should also be considered in these patients.

Keywords: Lower extremity edema, sacroiliac joint dysfunction, quality of life, posture

Öz

Amaç: Kronik alt ekstremite ödemi, postür bozukluğu, sakroiliak eklem disfonksiyonu ve anormal yürüyüş paterni ile ilişkilendirilmiştir. Lenfödem ve lipödem, kronik alt ekstremite ödeminin önemli nedenleridir. Bu çalışmada alt ekstremite ödemi olan hastalarda sakroiliyak eklem disfonksiyonu ve postürel bozuklukların varlığı ve aralarındaki ilişkiyi araştırmayı amaçladık.

Gereç ve Yöntem: Çalışmamız prospektif, karşılaştırmalı kesitsel bir çalışmadır. Çalışmaya alt ekstremite ödemi olan 53 hasta ve 53 sağlıklı kişi dahil edildi. Sakroiliak eklem disfonksiyonu tanısı içi ağrı provokasyon testleri kullanıldı. Postür analizi, PostureScreen® Mobile 11.2 (PostureCo, Inc., Trinity, FL) yazılımı ile gerçekleştirildi. Katılımcıların yaşam kaliteleri Lenfödem Yaşam Kalitesi Ölçeği (LYMQOL) ile, fonksiyonel durumları ise Oswestry Dizabilite İndeksi ve Alt Ekstremite Fonksiyonel Skalası ile belirlendi.

Bulgular: Alt ekstremite ödemi olan hastalarda sakroiliyak eklem disfonksiyonu daha sıktı (%18.9). Alt ekstremite hacim farkları ve yüzdeleri ile sakroiliyak eklem arasında pozitif korelasyon saptandı. Ödem grubunda baş, omuz ve kalça açılarında deviasyonlar saptandı. Ödem grubunda sakroiliyak eklem disfonksiyonu olan hastalarda Q açısı, lateral omuz angulasyonu ve LYMQOL-leg ölçeği total skoru daha yüksekti.

Sonuç: Çalışmamızda kronik alt ekstremite ödemi ile postural sapma ve sakroiliyak eklem disfonksiyonu arasında ilişki bulundu. Kronik alt ekstremite ödemi olan hastalarda ödem kontrolünün yanı sıra, postür analizi ve sakroiliak eklem değerlendirmesi uygun bir yaklaşım gibi gözükmektedir.

Anahtar Kelimeler: Alt ekstremite ödemi, sakroiliyak eklem disfonksiyonu, yaşam kalitesi, postür

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INTRODUCTION

Chronic lower extremity edema is a multifactorial condition mainly caused by venous and lymphatic insufficiency. The prevalence varies between 7-20%. Lymphedema and lipedema have an important place among the factors that cause chronic lower extremity edema.[1] Lymphedema causes a progressive decrease in joint movements and muscle strength, musculoskeletal pathologies, gait abnormalities, and postural instability due to immobility.[2] The presence of lower extremity lymphedema has a negative effect on balance.[3] Lipedema causes gait disorders by affecting the hip and knee joints due to abnormal fat accumulation in the lower extremities.[3,4]

The sacroiliac joint (SIJ) connects the spine to the pelvis and transfers body weight to the lower extremities.[5] SIJ pain is one of the most common causes of chronic low back pain and accounts for 15-30% of patients.[6] SIJ dysfunction (SIJD) results from sliding and torsional forces during activities such as walking, running, and squatting. Extremity volume load and differences cause asymmetrical stress to the pelvis during walking. It is suggested that this situation will increase the shear force in SIJ and cause damage to the joint.[7]

To the best of our knowledge, there is no study yet on which of the postural alignment and stability parameters are affected by lower extremity edema. This study aimed to detect the presence of SIJD and postural disorders in patients with lower extremity edema and the relationship between them.

MATERIAL AND METHOD

Data collection/recruitment procedure

This study is a comparative prospective cross-sectional study. The study was conducted between September 2020 and October 2021 and approved by the Clinical Research Ethics Committee of Süleyman Demirel University Faculty of Medicine (dated 25.09.2020, numbered 281). The universe of the study consisted of patients diagnosed with lymphedema and lipedema and admitted to our outpatient clinic. The control group was selected from volunteer relatives of the hospital staff in a similar age range to patients. All cases were informed in detail about the study's content, purpose, and application, and their written informed consents were obtained.

Fifty-three volunteered patients with lower extremity edema (lipedema and lymphedema) for more than six months and healthy volunteers of similar age were included in the study. Exclusion criteria were as follows: being younger than 18 years of age, illiteracy, being pregnant, a cognitive impairment that prevented answering the questionnaire questions for the study, extremity pathology due to rheumatological disease, history of major musculoskeletal trauma and malformations, presence of neurological disease and active malignancy.

The demographic characteristics of the patients, duration, stage, and localization of edema, presence of accompanied disease and disease duration, surgery history, lymph node dissection history, chemotherapy and radiotherapy history, and pain status of all patients included in the study were recorded.

The staging and volumetric circumference measurements of patients diagnosed with lymphedema and lipedema and physical examination consisting of goniometric joint range of motion (ROM) measurement, sacroiliac joint dysfunction tests, and postural analysis were performed and recorded. The same physiatrist performed all measurements and examinations.

Lymphedema quality of life for lower extremity (LYMQOL-Leg) questionnaire, lower extremity functional scale (LEFS), and Oswestry disability index (ODI) were filled out by the patients.

Assessment tools and scales

Volumetric Circumference Measurement

The extremity volumes of the patients were evaluated by the circumferential measurement method. In both lower extremities, the circumference of the metatarsophalangeal joint, the ankle (2 cm proximal to the medial malleolus midpoint), and the entire lower extremity towards the proximal 4 cm intervals were measured symmetrically with a tape measure (**Figure 1**).[8]

Figure 1. Lower extremity circumferential measurement method

The obtained data were transferred to the Excel Cone program, and the edema volume and percentage were calculated.

Staging

Lymphedema and lipedema grading is done in 4 stages. Lymphedema staging was done according to the 2016 consensus report of the International Society of Lymphology:

- Stage 0: This stage describes a subclinical state where swelling is not evident despite impairments in lymph transport.
- Stage 1: Pitting edema occurs without secondary tissue changes. In this stage elevation reduces swelling.
- Stage 2: Non-pitting irreversible edema with positive Stemmer's sign (The skin on the second toe of the foot cannot be lifted when it is grasped, squeezed, and tried to be lifted).

- Stage 3: This is the stage of lymphocytic elephantiasis with acanthosis, fat deposits, fibrosis, hyperpigmentation, and trophic skin changes.

The Meier-Vollrath and Schmeller classification system was used for lipedema staging.[9]

- Stage 1: The skin is smooth but the tissue under the skin has a pebble-like feel, which suggests fibrosis in the tissue
- Stage 2: There is more lipedema tissue, the skin has dimpling due to fibrotic changes in the skin and underlying loose connective tissue, and the nodules are larger.
- Stage 3: Large fat lobules are seen medial to the knee and thigh.

Sacroiliac Joint Examination and Dysfunctional Evaluation

Pain provocation tests were used in the evaluation of SIJD. These tests are FABER (Patrick) test, compression test, distraction test, Gaenslen test, sacral thrust test, and thigh thrust test. Positive tests are interpreted as an indicator of increased SIJ sensitivity.[10]

Three or more test positivity has a sensitivity of 85% and a specificity of 76-79% and is considered significant in terms of SIJD.[11-13] In this study, at least three positive tests were accepted as diagnostic for SIJD.

Postural Evaluation

Postural assessment was performed with PostureScreen® Mobile 11.2 (PostureCo, Inc., Trinity, FL) application in all cases included in the study.

PostureScreen® Mobile (PSM) is a specially designed app to objectively evaluate patients' posture, movement, and body composition with a photographic method.[14] Its validity and reliability have been demonstrated.[15] The patient should be minimally dressed during the analysis.[16]

Gender, date of birth, height, and body weight of all cases were recorded in the application. The subjects were positioned with their feet parallel to each other, medial malleolus at the same level, and arms free to the sides. The camera of the mobile phone was fixed at a distance of 3 m and a height of 1.30 m. A total of 4 photographs were taken in the anterior, posterior, right, and left lateral planes. A green target-like screen appears when the device was level to ensure standardization in photography.

Postural evaluation in PSM application is based on the principle of marking the anatomical reference points on the photographs taken.[16] The reference points determined after each photo shoot were marked. These reference points are;

- Anterior plane; right and left pupil, nasal filter, acromioclavicular joint, upper end of the sternum, right and left lateral ribs (T8), right and left SIAS, patella, tibial tuberosity, and ankle joint midline,
- Lateral plane; lateral edge of the eye, external meatus, C7 vertebra, acromioclavicular joint, thoracic kyphosis apex, lower thoracic vertebra (T12), SIPS, SIAS, greater trochanter, knee articulation line, and lateral malleolus,
- Posterior plane; earlobe, C7 spinous process, acromioclavicular joint, T4 spinous process, right and left rib (T8), T12 spinous process, L3 spinous process, right and left SIPS, and bilateral Achilles tendon.

After the reference points were marked manually, measurements were made with the PSM application, and analysis results were obtained in pdf format (**Figure 2**).

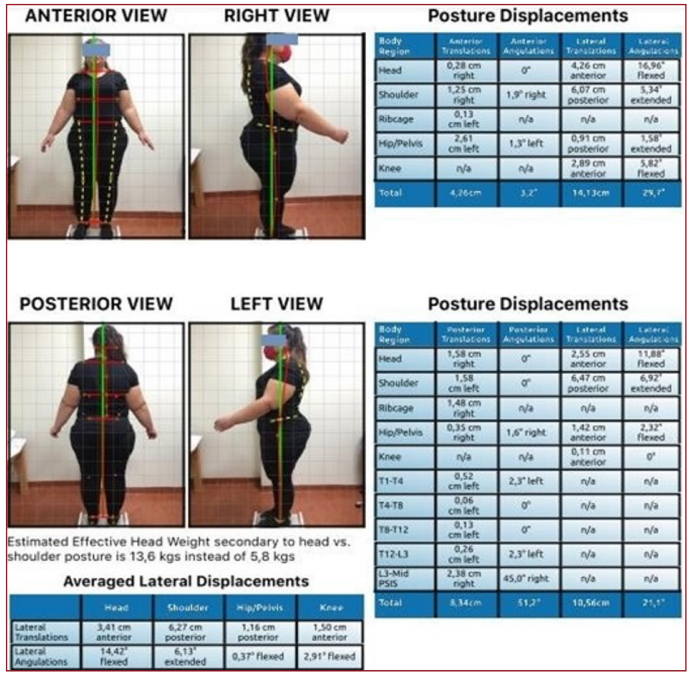

Figure 2: Postural analysis pdf document achieved with PostureScreen® Mobile application

In the results obtained, various postural variables were analyzed in the coronal and sagittal planes. The postural variables used in the PSM application were as follows: (1) anterior head angulation, shoulder angulation, hip angulation, right and left Q angle; (2) sagittal: head angulation (right and left), shoulder angulation (right and left), hip angulation (right and left), knee angulation (right and left), thoracic kyphosis angle, pelvic tilt; (3) posterior: head angulation, shoulder angulation, hip angulation.

Lymphedema Quality of Life for Lower Extremity Questionnaire (LYMQOL-Leg)

The LYMQOL-Leg is a 27-item, a 4-part scale developed to evaluate the impact of lower extremity lymphedema on quality of life.[17] It consists of 26 multiple-choice questions assessing symptoms, appearance, daily physical activities, emotional state, and a visual analog scale that questions the general quality of life. Each item is scored between 1 and 4 on a Likert-type scale (1: not at all, 2: a little, 3: quite a lot, 4: a lot). If any item is left blank or more than 50% of the questions per section are not answered, a score of "0" is given. Individual

scores are added in each section, and the calculation is made by dividing the total by the number of questions answered. A high score indicates poor quality of life of the patient. The Turkish validity and reliability study of the scale was conducted.[18]

Lower Extremity Functional Scale (LEFS)

LEFS was developed to assess the functional status of patients with musculoskeletal dysfunction affecting the lower extremities.[19] The scale consists of 20 items. Each question has five options from 0 to 4 (0: extremely difficult or unable to do the activity, 1: quite difficult, 2: moderately difficult, 3: somewhat difficult, 4: not difficult at all). The total score ranges from 0 to 80, with higher scores indicating better functional status. The Turkish validity and reliability study of the scale was conducted.[20]

Oswestry Disability Index (ODI)

ODI was developed to evaluate functional disability in patients with low back pain.[21] In this scale, ten questions evaluate daily life activities such as pain intensity, self-care, lifting, walking, standing, sleep status, travel, and social life. Each question is scored between 0-5. The total score in scoring is a minimum of 0 and a maximum of 50. The higher the total score, the higher the disability level. The Turkish validity and reliability study of the scale was conducted.[22]

Statistical Analysis

SPSS 25.0 (IBM Inc., Chicago, IL, USA) program was used in the statistical analysis of the study. Descriptive measures are presented as mean±standard for normally distributed data, median (min-max) for non-normally distributed data, and frequency (percentage ratio) for categorical variables. The conformity of continuous numerical data to normal distribution was analyzed by the Kolmogorov-Smirnov test. Independent Sample t-Test was used to analyze the difference between groups of normally distributed numerical variables, and the Mann-Whitney U test was used for non-normally distributed variables. The difference in nominal variables between groups was analyzed with the Chi-square test. Correlation analyzes were performed using the Spearman correlation test. Type 1 error value was taken as 5%, and the $p<0.05$ value was considered statistically significant.

Before starting the study, the minimum number of participants was determined as 51 by applying Power Analysis with 80% power and type 1 error level (5%) to ensure the study's reliability. The G power 3.1.9.2 Software (Universität Düsseldorf) program was used for power analysis.

RESULTS

Fifty-three lymphedema and lipedema patients and fifty-three healthy controls were included in the study. Twelve patients were not included in the study because they did not want to be photographed. Four patients were excluded because of the presence of chronic rheumatic disease, and seven patients were due to active malignancy. There were forty-eight female and five male patients in the edema group and forty-nine females and four males in the control group (P=0.870). There was no statistical difference in the mean age of the patient group and control group (58.92±9.84, 58.19±8.12, respectively; P=0.457). The mean BMI of the patient group was statistically higher than the control group (33.7±5.9, 30±3.8, respectively; P<0.001). Lipedema was detected in 42.5% and lymphedema in 54.8% of the patients. Edema was bilateral in 60.4% of the patients, on the right side in 11.3%, and on the left in 28.3%. Stage 2-3 edema was detected in 88.7% of patients, stage 1 in 9.4%, and stage 4 edema in 1.9%. Edema was located in the entire lower extremity in 83% of the patients, distal in 15.1%, and proximal in 1%.

SIJD was detected in 10 (18.9%) cases in the edema group and 3 (5.6%) cases in the control group. A statistically significant difference was found between the two groups in terms of SIJD (P=0.038). In the edema group, left-sided SIJD was detected in all patients with bilateral edema, and contralateral SIJD was detected in all patients with unilateral edema. The edema duration, volume difference, and volume percentage of the patients in the edema group with and without SIJD are compared in **Table 1.**

Table 1. Comparison of the demographic and clinical characteristics of the cases with and without SIJD in the edema group

Clinical characteristics	Patients with SIJD (n=10, 18.9%)	Patients without SIJD (n=43, 81.9%)	P
Age (year)	60.50 (47-74)	61 (31-74)	0.486*
BMI (kg/m2)	30.70 (25-61)	33.55±4.57	0.643*
Disease duration (month)	98.10±67.83	84 (7-480)	0.706*
Duration of edema (month)	67.30±44.89	72 (7-480)	0.298*
Volume difference (ml)	983.5 (385-7190)	326 (36-2621)	0.002*
volume percentage (%)	15 (6-150)	5.8 (1-71)	0.001*

SIJD: sacroiliac joint dysfunction; SD: standard deviation; BMI: body mass index, *Mann-Whitney U test **Independent Sample t-Test, Mean±SD for normally distributed data and median (min-max) for non-normally distributed data are used.

The correlation between the presence of SIJD and edema localization, duration, stage, and the correlation between the presence of SIJD and the volume difference and percentage are shown in **Table 2.**

Table 2. Correlation analysis between the presence of SIJD and edema localization, stage, duration, and volume in the edema group

	Cases with SIJD (n=10)	
	r	P
Localization	-0.034	0.810
Stage	0.153	0.276
Duration of edema (month)	-0.063	0.653
Volume difference (ml)	0.433	0.001
Volume percentage (%)	0.397	0.003

SIJD: sacroiliac joint dysfunction *Spearmen Correlation Analysis

The comparison of the postural analysis results of edema and control groups is shown in **Table 3**.

Table 3. Posture analysis of edema and control groups

Variables		Edeme group (n=53)	Control group (n=53)	P
	Head angulation	2.10 (0-6.4)	1.36±11.59	0.008*
	Shoulder angulation	1.90 (0-7.9)	1.12±0.94	<0.001*
Anterior	Hip angulation	2.52±2.02	1.20 (0-7.9)	0.002*
	Q angle (right)	7.27±4.86	6.79±3.10	0.053**
	Q angle (left)	7.74±4.86	6.12±2.78	0.031**
	Head angulation	14.94±7.18	8.05±5.05	<0.001**
	Shoulder angulation	3.12±1.98	2.30 (0-7.72)	0.098*
Lateral	Hip angulation	2.47 (0.02-14.97)	2.17 (0-8.25)	0.102*
	Knee angulation	6.93 (0.89-23.59)	4.82±2.36	0.001*
	Pelvic tilt	20.61±5.62	19.66±4.78	0.350**
	Thoracic kyphosis	30.8 (14.5-41.2)	30.05±5.49	0.832*
	Head angulation	1.60 (0-6.6)	1.30(0-5.9)	0.014*
Posterior	Shoulder angulation	1.40 (0-4)	1.2 (0-3)	0.004*
	Hip angulation	1.60 (0-12.2)	2.14±1.44	0.601*

* Mann-Whitney U test **Independent Sample t-Test Mean±SD for normally distributed data and median (min-max) for non-normally distributed data are used.

In the edema group, the left knee Q-angle in the anterior plane and the shoulder angle in the lateral plane were higher in patients diagnosed with SIJD compared to those not diagnosed with SIJD (P=0.025, P=0.036, respectively). No statistically significant difference was found between the groups in the posture analysis of the cases with unilateral and bilateral edema (P>0,05).

The comparison of the LYMQOL-leg total score, ODI, and LEFS scores of the edema subgroups is shown in **Table 4**. Functional status and general quality of life, which are sub-parameters of the LYMQOL-leg scale, were statistically higher in patients with bilateral edema, and emotional status was statistically higher in the presence of SIJD (P=0.036, P=0.037, P=0.003, respectively).

DISCUSSION

This study found that SIJD developed more frequently in patients with lymphedema/lipedema, and contralateral dysfunction developed more in patients with unilateral edema. The increase in the volume of edema in the lower extremities was correlated with the development of dysfunction. The patients with edema had deviations in the angulations of the head, shoulders, and hips. Patients with edema and SIJD had poor quality of life. Functional status and general quality of life of patients with bilateral edema were more adversely affected.

Leg length difference, scoliosis, abnormal gait pattern, and abnormal or asymmetric loading are risk factors for SIJD.[23,24] It has been suggested that unilateral volume increase due to unilateral lower extremity lymphedema causes asymmetrical loading during walking, leading to tension in SIJ due to increased shear force.[24] There is no study on the mechanism of the SIJD caused by chronic lower extremity edema, except for only one case report dealing with this relationship. Crane reported.[7] 50 years old female patient with SIJD secondary to unilateral lower extremity lymphedema. The volume difference and percentage between the lower extremities of our patients with SIJD were high, and a correlation was found between the presence of SIJD and the volume difference.

SIJ is a component of the lumbopelvic system and effectively transmits compressive loads between the lumbar spine and the lower extremities.[25] Vleeming et al.[26] defined that the posterior thoracolumbar fascia provides load transfer between the ipsilateral latissimus dorsi and the contralateral gluteus maximus. This myofascial connection, called the posterior oblique sling, provides lumbopelvic stability and the functional connection between the lumbar spine and the lower extremity during walking. The load on one side affects the contralateral side with this myofascial sling mechanism.[27] We found that SIJD developed on the contralateral side in patients with unilateral edema. We interpreted that the contralateral side may be affected by the increased stress on the contralateral joint with the myofascial sling or by the effect of the pelvic torsion resulting from abnormal loading.

The ODI is a reliable and validated scale for assessing disability caused by the lumbar region and SIJ pain.[21] There was no difference in ODI scores between our patients with and without SIJD in the edema group. Patients without SIJD may have high ODI scores due to other possible causes of low back pain.

Lower extremity edema significantly affects the quality of life due to physical and psychosocial problems.[28,29] However, a limited number of studies evaluated the quality of life in patients with lipedema and lymphedema in the lower extremities.[17] Greene and Meskell[30] determined that edema has physical, psychological, and social effects. It was found that all subgroup measurement scores of the LYMQOL scale improved by decongestive lymphatic therapy.[31] In accordance with the literature, we observed that the functional status and general quality of life were affected in patients with bilateral edema. Telli et al.[32] suggested that the presence of SIJD in patients with lumbar disc herniation caused an increase in depression. Similarly, we found that the emotional state was more affected in patients with dysfunction.

Table 4. Comparison of the quality of life and functional scores of the edema subgroups

Groups, n(%)	LYMQOL-leg	P	ODI	P	LEFS	P
Unilateral edema, 21 (39.7)	6 (1-9)	0.212*	30 (0-46)	0,270*	44 (28-77)	0.315*
Bilateral edema, 32 (60.3)	4 (1-9)		32 (8-71)		42.5 (17-70)	
SIJD (+), 10 (18.9)	4.5 (1-7)	0.017*	34.5 (22-71)	0.098*	40 (17-64)	0.084*
SIJD (-), 43 (81.9)	5 (1-9)		32 (0-64)		44 (22-77)	

LYMQOL-leg: Lymphedema Quality of Life for Lower Extremity Questionnaire; ODI: Oswestry Disability Index; LEFS: Lower Extremity Functional Scale, SIJD: Sacroiliac joint dysfunction, * Mann-Whitney U test, Median (min-max) for non-normally distributed data are used.

Lymphedema causes a progressive decrease in joint movements, muscle strength, gait abnormalities, and postural instability due to inactivity.[2] Posture analysis evaluates the deviations resulting from asymmetry on the right and left sides of the body and segmental rotations in the frontal, sagittal and transverse planes.[33] The use of postural assessment tools with mobile applications has increased in the past decade.[34] The PSM was the most used application tool in posture analysis between 2012 and 2020.[35] We used the PSM application for postural assessment and found that postural disorders occur in cases with edema.

In the postural analysis of our study, we found an increase in head, shoulder, and hip angulations in edematous cases. We did not detect significant changes among those with unilateral and bilateral involvement in the edema group. To our knowledge, this is the first study to evaluate posture in chronic lower extremity edema. Therefore, we could not find any data to compare these results in the literature.

An increase in the Q angle is associated with patellofemoral pain syndrome, chondromalacia patella, patellar subluxation, and patellar hypermobility.[36] We found a difference in left-sided Q angle in patients diagnosed with SIJD in the edema group. This result might be because patients with dysfunction were predominantly affected on the left side. Since the possible patellofemoral pathologies of the patients were not evaluated in our study, it is not possible to mention this with certainty.

Study limitations: 1) lower extremity volumes of the cases with bilateral edema were not given separately, 2) the 3D analysis could not be performed, 3) not all of the cases were minimally dressed, and 4) the inability to use anatomical markers.

CONCLUSION

Postural changes and SIJD may occur in patients with chronic lower extremity edema. Both edema and SIJD reduce the quality of life. Patients with chronic lower extremity edema should be evaluated regarding postural disorders and SIJD.

ETHICAL DECLARATIONS

Ethics Committee Approval: Approved by the Clinical Research Ethics Committee of Süleyman Demirel University Faculty of Medicine (dated 25.09.2020, numbered 281).

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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