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The Relationship Between Hand Function and Activities of Daily Living in Patients with Hypothyroidism

ABSTRACT

Objective: This study aimed to evaluate hand function and hand function-related factors in patients with hypothyroidism and to investigate the relationship between hand function and activities of daily living.

Methods: This cross-sectional study included 103 patients with hypothyroidism (53 with Hashimoto thyroiditis, 50 with postoperative hypothyroidism) and 50 controls. Hand function was evaluated with the Duruoz Hand Index, and the Nottingham Extended Activities of Daily Living Scale was used to assess activities of daily living.

Results: The mean Duruoz Hand Index scores were higher in the Hashimoto group (1.70 ± 4.71) ($P = .02$) and postsurgical group (2.16 ± 4.37) ($P = .002$) than in the control group (0.24 ± 1.02). The median Nottingham Extended Activities of Daily Living Scale score was 65 (45-66) in patients with Hashimoto thyroiditis, 63 (43-66) in patients with postsurgical hypothyroidism, and 66 (46-66) in the control group ($P = .009$). The difference was statistically significant between the control group and Hashimoto ($P = .037$) and postsurgical ($P = .001$) groups. The cut-off value of the Nottingham Extended Activities of Daily Living Scale determined with receiver operating characteristics analysis for poor and good activities of daily living status was 63.5 with a sensitivity of 70% and a specificity of 54% (area under the curve: 0.643, 95% CI: 0.553-0.733, $P = .004$) for this study. Logistic regression analysis showed that Duruoz Hand Index ($B = -0.695$, $P = .011$) and female gender ($B = -2.477$, $P = .028$) were predictive variables for activities of daily living ($R^2 = 0.43$).

Conclusion: Hand function was worse, and activities of daily living were lower in patients with hypothyroidism. Since poor hand function may affect activities of daily living, clinicians should routinely assess hand function and activities of daily living in patients with hypothyroidism. A multidisciplinary approach including rehabilitation programs, must be considered if hand dysfunction is detected.

Keywords: Activities of daily living, hand function, Duruoz Hand Index, Hashimoto thyroiditis, hypothyroidism

Introduction

Skeletal muscle is one of the primary targets of thyroid hormone signaling, which affects muscle contractility and metabolism.[1] The binding of triiodothyronine (T3) to thyroid nuclear receptors is essential for normal muscle development, homeostasis, and regeneration.[1] Thus, thyroid dysfunction may cause musculoskeletal problems. Patients with hyperthyroidism or hypothyroidism may suffer from muscle pain, weakness, and even myopathy.[2,3] Recent research concluded that thyroid hormones could have a role in the sarcopenic process also.[4] Besides muscle symptoms, some patients have effusions at the knees or small joints such as metacarpophalangeal, proximal interphalangeal, and metatarsophalangeal joints.[5,6] Dupuytren contracture, limitation of joint mobility, carpal tunnel syndrome, and trigger finger are common musculoskeletal problems in patients with hypothyroidism.[5] All these problems may lead to hand dysfunction, reduced activity of daily living (ADL) performance, and disability in self-care of the patients. A previous study reported that hand function scores were worse in patients with hyperthyroidism compared to the controls.[7] Spira et al[2] reported that above and below the normal limits of thyroid-stimulating hormone (TSH) levels were associated with lower handgrip strength in the young and middle-aged participants. As far as we know, the data about hand function in hypothyroidism are lacking. This study aimed to evaluate hand function and hand function-related factors in patients with hypothyroidism and investigate the relationship between hand function and ADL.

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Materials and Methods

Study Design and Patient Inclusion

Between January 2022 and May 2022, 103 patients with hypothyroidism, 53 patients with Hashimoto thyroiditis, and 50 patients with postoperative hypothyroidism, presented to the Endocrinology and Metabolism Outpatient Clinic of our hospital, and 50 consecutive controls were included in this cross-sectional study. Patients with hypothyroidism who had been using levothyroxine treatment for at least 1 year were incorporated. Patients with diabetes mellitus (DM), neurologic disorders, malignancy, pregnancy, rheumatologic diseases, renal failure with estimated glomerular filtration rate <60 mL/min/1.73 m^2), cervical radiculopathy, upper extremity trauma or surgery history, restricted hand motion due to skin lesions or restricted joint motion due to hand osteoarthritis, carpal tunnel syndrome, and cognitive or psychiatric disorders were excluded. The Clinical Research Ethics Committee of Dışkapı Yıldırım Beyazıt Training and Research Hospital approved this study (approval no: 128/10, date: January 10, 2022). Written informed consent was taken from all participants.

Baseline characteristics, anthropometric measurements, body mass index (BMI), dominant hand site, and education duration of all participants were obtained. Disease duration and levothyroxine dose of the patients were noted. Thyroid-stimulating hormone and free thyroxine (fT4) levels of all participants and anti-thyroid peroxidase and anti-thyroglobulin autoantibody of the patients with Hashimoto thyroiditis were examined.

The Duruoz Hand Index (DHI), also called the Cochin Hand Functional Disability Scale, was used to evaluate hand function.[8] Duruoz Hand Index is a self-reporting survey consisting of 18 items, including hand ability in the kitchen, during dressing, while doing personal hygiene, office tasks, and other general items.[9] The total score is between 0 and 90. According to this questionnaire, higher scores indicate worse hand function. The validation and reliability study of the DHI showed that Cronbach's alpha was 0.97 and the intraclass correlation coefficient (ICC) value of the total score was 0.88.[8] The Nottingham Extended Activities of Daily Living Scale (NEADLS) was used to evaluate functional levels in activities of daily living (ADL).[10] The NEADLS compose of 4 subsections; mobility (6 items), kitchen (5 items), domestic (5 items), and leisure time activities (6 items). The total NEADLS score ranges between 0 and 66. Higher scores point out better daily activity levels. The Cronbach's alpha for the total NEADLS was 0.97, and the ICC value of the total score was 0.97 in the validation and reliability study.[10]

Statistical Analysis

Nominal variables are presented as numbers and percentages (%). The normality of distribution for continuous variables was confirmed with the Shapiro–Wilk test. Normally and non-normally distributed variables were presented as mean ± standard deviation (SD) and median (minimum-maximum), respectively. The comparison of independent continuous variables, which are normally distributed, was performed by the Student's *t*-test. The Mann–Whitney *U* test and the Kruskal–Wallis test were used when analyzing the differences between non-normally distributed variables among hypothyroidism subgroups and controls. The differences in the DHI and the NEADLS scores among the 3 groups were analyzed with the Kruskal–Wallis test. The Mann–Whitney *U* test was used to compare the DHI and NEADLS scores between subgroups such as the controls-Hashimoto thyroiditis group, controls-postsurgical group, and Hashimoto thyroiditis-postsurgical groups. The patients in the 2 hypothyroidism groups categorized according to their disease duration as under and above 10 years were compared by using the Mann–Whitney *U* test. Where appropriate, the chi-square test or Fischer's exact test (when chi-square test assumptions do not hold due to low expected cell counts) was performed when comparing the proportions of the hypothyroidism and control groups. Spearman's correlation test was used for determining associations between non-normally distributed or ordinal variables. Univariate and multivariate regression analyses were performed to determine predictive variables for DHI. Receiver operating characteristics (ROC) analysis was used for defining good and poor ADLs status for this study, and logistic regression analysis was examined to determine the final predictive factors for ADLs. For all tests, *P*-values less than .05 were considered to show statistically significant results.

Results

About 53 patients with Hashimoto thyroiditis, 50 patients with postoperative hypothyroidism, and 50 controls were included in the study. The age and sex distribution of the 3 groups were similar ($P > .05$). The participants' demographic variables, laboratory test results, and questionnaire scores are presented in Table 1.

The mean DHI score was 1.70 ± 4.71 in patients with Hashimoto thyroiditis, 2.16 ± 4.37 in patients with postsurgical hypothyroidism, and 0.24 ± 1.02 in controls ($P = .009$). The mean DHI scores were higher in the Hashimoto group ($P = .02$) and postsurgical group ($P = .002$) than in the control subjects. No difference was observed between the Hashimoto and the postsurgical groups ($P = .375$).

The DHI score was found to be negatively correlated with the NEADLS score ($r = -0.473$, $P < .001$) in patients with hypothyroidism. No correlation was observed between DHI and age, education duration, disease duration, BMI, weight, height, fT4, and TSH level ($P > .05$). No difference was observed in subgroups of the patients in Hashimoto and postsurgical hypothyroidism groups under and above the 10-year of disease duration ($P = .109$, $P = .488$, respectively). No relationship was found between DHI and sex and the dominant hand in the hypothyroidism subgroups ($P > .05$). There was no predictive variable for the DHI in the univariate and multivariate analyses ($P > .05$).

The median NEADLS score was 65 (45-66), 63 (43-66), and 66 (46-66) in the patients with Hashimoto thyroiditis, postsurgical hypothyroidism, and controls, respectively ($P = .009$). Although no difference was determined between Hashimoto thyroiditis and postsurgical groups ($P = .115$), the difference was statistically significant between the control group and Hashimoto ($P = .037$) and postsurgical ($P = .001$) groups. Nottingham Extended Activities of Daily Living Scale score

MAIN POINTS

- Hand function was worse, and activities of daily living function was lower in patients with hypothyroidism than in the controls.
- Hand function and activities of daily living scores were similar in the patients with postsurgical hypothyroidism and Hashimoto thyroiditis.
- Poor hand function and female gender were predictive variables for poor activities of daily livings in patients with hypothyroidism.

Table 1. Demographic Variables, Laboratory Test Results, and Questionnaire Scores of the Participants

	Patients with Hashimoto Thyroiditis (n = 53)	Patients with Postsurgical Hypothyroidism (n = 50)	Controls (n = 50)	*P*
Age, years	45.8 ± 10.65	46.7 ± 8.1	46.14 ± 10.8	.902
Female gender, (n, %)	46 (86.6)	42 (84)	39 (78)	.481
Education duration, (years)	11 (8-15)	11 (8-15)	13 (8-15)	**.028**
Disease duration, (years)	9 (1-30)	10 (1-25)		.352
BMI, (kg/m^2)	28.5 (19.2-42)	27.9 (20.2-38.1)	25.3 (19.5-34.9)	**.002**
Weight, (kg)	77 (51-101)	78 (53-115)	70 (50-105)	0.073
Dominant hand, (n,%)				
Right	50 (94.3)	48 (96.0)	46 (92.0)	.475*
Left	3 (5.7)	2 (4.0)	4 (8.0)	
TSH, mIU/L	2.45 (0.07-17.00)	1.66 (0.01-18.70)	1.66 (0.48-4.30)	.090
FT4, ng/dL	1.15 (0.96-1.44)	1.10 (0.78-1.50)	1.12 (0.66-1.43)	.830
Anti-TPO, IU/mL	10 (0.3-1200)			
Anti-TG, IU/mL	13.5 (0.5-2500)			
DHI score	1.70 ± 4.71	2.16 ± 4.37	0.24 ± 1.02	**.009**
NEADLS score	65 (45-66)	63(43-66)	66 (46-66)	**.003**

*Fisher's exact test was used for comparing the dominant hand between the hypothyroid group (Hashimoto's disease and postsurgical) and the control group because 1 cell (25%) has an expected count of less than 5.
Anti-TPO, anti-thyroid peroxidase antibody; anti-TG, anti-thyroglobulin antibody; BMI, body mass index; DHI, Duruoz Hand Index; fT4, free thyroxine; NEADLS, The Nottingham Extended Activities of Daily Living Scale; TSH, thyroid-stimulating hormone.

Table 2. Correlations Among Baseline Characteristics, Anthropometric Measurements, Thyroid Hormones, and DHI and NEADLS Scores in the Patients with Hypothyroidism (n = 103)

	Age	Education Duration	Disease Duration	BMI	Weight	TSH	fT4	NEADLS
DHI	*r* = −0.108	*r* = −.0.134	*r* = −.0.024	*r* = −.0.105	*r* = −.0.190	*r* = 0.071	*r* = 0.060	*r* = −.0.473
	P = .276	*P* = .176	*P* = .809	*P* = .307	*P* = .063	*P* = .479	*P* = .552	***P* < .001**
NEADLS	*r* = 0.017	*r* = 0.290	*P* = −0.233	*r* = −.0.206	*r* = −.0.013	*r* = −.0.077	*r* = −.0.023	-
	P = .867	***P* = .003**	***P* = .018**	***P* = .043**	*P* = .896	*P* = .479	*P* = .817	

BMI, body mass index; DHI, Duruoz Hand Index; fT4, free thyroxine; NEADLS, The Nottingham Extended Activities of Daily Living Scale; TSH, thyroid-stimulating hormone.

was positively correlated with education duration ($r = 0.290$, $P = .003$) and negatively correlated with disease duration ($r = -0.233$, $P = .018$), BMI ($r = -0.206$, $P = .043$), and DHI ($r = -0.477$, $P = .001$) in the whole hypothyroidism group. The median NEADLS was 63 (43-66) in female patients and 66 (58-66) in males with hypothyroidism ($P = .001$). There was no correlation between NEALDS and age, dominant hand, weight, TSH, and fT4 levels ($P > .005$). Correlations between patients' characteristics, DHI, and NEADLS are presented in Table 2. The cut-off value of the NEALDS, which was determined with ROC analysis for poor and good ALDs status, was 63.5 with a sensitivity of 70% and a specificity of 54% (area under the curve: 0.643, 95% CI: 0.553-0.733, $P = .004$) for this study. While the mean DHI score was 0.23 ± 1.20 in patients with good ADLs, it was 3.34 ± 5.69 in patients with poor ADLs status ($P = .001$). Logistic regression analysis showed that DHI ($B = -0.695$, $P = .011$) and female gender ($B = -2.477$, $P = .028$) were predictive variables for ADLs ($R^2 = 0.43$). Logistic regression analysis results of the factors associated with the NEADLS in patients with hypothyroidism are presented in Table 3.

Discussion

This research demonstrated that hand function and ADL were worse in patients with hypothyroidism than in healthy individuals. However, the difference in hand function and ADL scores was not statistically significant between the postsurgical and Hashimoto thyroiditis groups. The second major result was that poor hand function and female gender were predictive variables for poor ADLs in patients with hypothyroidism. As far as we know, this is the first study assessing the relationship between hand function and ADLs in patients with hypothyroidism.

Table 3. Logistic Regression Analysis Results for ADLs Status (n = 103)

			95% CI	
Variable	***B***	***P***	**Lower**	**Upper**
Age	0.0	.994	0.941	1.063
Sex (female vs. male)	−2.477	**.028**	0.009	0.761
Education duration	0.205	.479	0.696	2.165
Disease duration	−0.044	.319	0.878	1.043
TSH level	−0.011	.888	0.850	1.151
DHI	−0.695	**.011**	0.293	0.851
BMI	−0.084	.139	0.823	1.028
Dominant hand	1.254	.303	0.322	38.069

ADLs, activities of daily living; BMI, body mass index; DHI, Duruoz Hand Index; TSH, thyroid-stimulating hormone.

Since the endocrine system is vital for body homeostasis, hormonal dysfunction may affect cardiovascular, pulmonary, gastrointestinal, genitourinary, dermatological, and musculoskeletal systems.[11] Thyroid hormones are one of the main regulators of the body, which regulate protein, carbohydrate, lipid, and mineral usage. Thus, thyroid dysregulation may cause dysfunction in every bodily system, including the musculoskeletal system.[11] Hands are one of the most used parts of the body during ADLs, and hand dysfunction may cause an impaired quality of life.[12] Although hand function was investigated in other endocrine diseases such as DM and acromegaly in previous studies, there is a lack of knowledge about hand function in patients with hypothyroidism.[5,11,13-15] The current study revealed that hand function was poorer in patients with hypothyroidism than in controls. A previous study evaluating hand function in patients with hyperthyroidism found reduced hand function without affecting handgrip strength.[7] Similar to our results, this study showed no significant correlation between TSH, fT4 levels, and DHI scores. The results of our study may be explained by dysfunction of the neuromusculoskeletal system, including muscles, nerves, and joints, due to thyroid dysregulation. A study investigating musculoskeletal manifestations in patients with thyroid disorders demonstrated that 21.7% of the patients with hypothyroidism had Dupuytren's contractures, 8.7% had limited joint motion, 4.3% had trigger finger, and 30.4% had carpal tunnel syndrome.[5] In addition, a musculoskeletal ultrasound (MSUS) study showed that MSUS abnormalities were associated with above or below TSH level.[6] Most of these reported conditions may cause hand dysfunction in patients with hypothyroidism. Since carpal tunnel syndrome (CTS) and severe hand osteoarthritis may affect hand function and a lot of risk factors for CTS and hand osteoarthritis are present, we excluded the history of CTS and restricted hand motion due to skin lesions or restricted joint motion due to hand osteoarthritis for avoiding these potential confounders in the present study.[16,17] We did not perform electromyography or ultrasonography on the patients because the main objective of our study was to evaluate hand function and the relationship between hand function and ADL. To reveal the pathophysiology of hand dysfunction, further research, including the evaluation of electromyography, radiography, and ultrasonography and measuring hand grip strength, is needed.

The present study revealed no relationship between hand function and age, sex, education duration, BMI, TSH level, fT4 level, disease duration, and dominant hand in the hypothyroidism group. We observed no difference between the patients of the 2 hypothyroidism groups when categorized according to disease duration as under and above 10 years. Sample size and the distribution of the patients in the subgroups may avoid observing any difference. In addition, hand dysfunction should be considered in patients with hypothyroidism regardless of thyroid hormone levels or personal characteristics. If hand dysfunction is detected, patients should be evaluated in a multidisciplinary approach, including an endocrinologist, physiatrist, orthopedist, physiotherapist, and ergotherapist.

Thyroid hormones have a role in muscular function, cardiovascular system, erythropoiesis, and oxidative stress, besides other organic functions, as mentioned before.[18] Thyroid dysfunction may influence health-related quality of life, mobility, and ADL, which describes the fundamental skills required for a person's independent self-care.[18,19] Numerous conditions such as aging, musculoskeletal, neurological, circulatory or sensory conditions, dementia, social isolation, the side effect of medication, hospitalization, acute illnesses, and the patient's home environment may affect ADL function.[19] The findings of our study suggested that ADL function was lower in patients with hypothyroidism than in healthy controls. A few studies analyzed the relationship between ADLs and thyroid function in the literature.[18,20-22] Gussekloo et al[20] designed a prospective observational study among 85-year-old individuals. They reported no relationship between the serum levels of TSH or fT4 and limitations in the ADL. Similarly, our study determined no correlation between ADL scores and TSH and fT4 levels. In contrast, Liu et al[21] reported that T3 level was positively associated with ADL in 146 geriatric patients; and Andersen-Ranbeg et al[22] reached the same result in 276 centenarians. Previous studies showed that quality of life (QOL) was worse in patients with hypothyroidism.[23,24] Hegedüs et al[23] concluded that impaired QOL in patients with primary hypothyroidism might be explained by the inability of levothyroxine alone to achieve adequate T3 levels in the tissues, inflammation caused by underlying autoimmunity, or other physical and psychosocial comorbidities.

The current study showed a positive relationship between ADL scores and education duration. However, ADL score was negatively correlated to BMI and disease duration in patients with hypothyroidism. When the cut-off point was determined with ROC analysis for good and poor ADLs status for the current study, logistic regression analysis showed that female gender and poor hand function were predictors for poor ADLs status. These findings pointed out that hand dysfunction is essential for independence in ADLs in patients with hypothyroidism. De Alegria et al[13] evaluated the functional levels of the patients with acromegaly using the Glittre Activities of Daily Living Test. Reduced functional capacity was found in patients with acromegaly, and hand function was related to ADL performance, supporting our data. Cederlund et al[25] evaluated ADLs in patients with DM and reported that ADL difficulties were related to longer disease duration but not to hand disorders. Our study did not have a significant correlation between ADL scores and age, TSH level, and fT4 level. Consistent with our results, data from the SHIP study and Berlin Aging Study II showed no relationship between TSH level and physical performance, which was evaluated by time up and go test.[2] Improving ADL function is very important for patients' independency. Even if the thyroid function tests were in the normal range, clinicians should consider that there may be a decline in ADLs.

The main limitations of the study were not evaluating hand strength and the higher education level of the control group. Other limitations include a wide range of disease duration, unknown disease duration before the diagnosis and treatment of Hashimoto thyroiditis, and not evaluating short and long-term effects of hypothyroidism on the musculoskeletal system. To the best of our knowledge, there is no validation study determining the cut-off point for classifying NEADLS as poor or good ADLs status, and the detected cut-off value for ADLs status was calculated with ROC analysis for only the current study. Further studies with larger sample sizes are needed to determine a generalizable cut-off point with high sensitivity and specificity for the classification of ADLs performance according to NEADLS.

In conclusion, hand function was worse, and ADLs were lower in patients with hypothyroidism. Since poor hand function may affect ALDs, clinicians should routinely assess hand function and ADLs in patients with hypothyroidism. A multidisciplinary approach,

including rehabilitation programs, must be considered if hand dysfunction is detected. Patients should be informed about how to increase their functional levels.

Ethics Committee Approval: The study was approved by the Ethics Committee of Dışkapı Yıldırım Beyazıt Training and Research Hospital (approval no: 128/10, date: January 10, 2022).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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