Ergoterapi ve Rehabilitasyon Dergisi, 12(2), 2024, 97-104

Research Article

Predictors of Balance in Individuals with Adhesive Capsulitis: A cross-sectional study

Adeziv Kapsülitli Bireylerde Dengenin Prediktörleri: Kesitsel bir Çalışma

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ABSTRACT

Purpose: The aim of this study was to determine whether the variables pain, mobility, upper extremity functionality and depression (mood status) are predictors of balance in individuals with Adhesive Capsulitis (AC). **Material and Methods:** A total of 40 individuals with AC, mean age 52.90 ± 6.02 years were included. Patients were assessed via Visual Analog Scale, 6-minute walk test, Time up and go test, Disabilities of Arm, Shoulder and Hand questionnaire, Beck Depression Scale and Berg Balance Scale to understand pain severity, functional mobility and capacity, upper extremity functional status, depression symptoms and balance. Multiple regression analysis was used to determine which predictor variables explain the outcome variable. **Results:** There was a moderate to high significant correlation of balance level with pain ($p<0.001$), functional capacity ($p<0.001$), depression ($p<0.001$) and upper extremity functionality ($p<0.001$) in patients with AC. In addition, resting pain ($p<0.048$) and functional capacity ($p<0.001$) are predictors of balance. **Conclusion:** Balance is adversely affected by increases in pain and depression levels. In addition, resting pain level and functional capacity are determinants of balance.

Keywords: Balance; Functional capacity; Pain.

ÖZ

Amaç: Bu çalışmanın amacı, Adeziv Kapsülitli (AK) bireylerde ağrı, mobilite, üst ekstremite fonksiyonelliği ve depresyon (ruhsal durum) değişkenlerinin, dengenin prediktörleri olup olmadığını belirlemektir. **Gereç ve Yöntem:** Çalışmaya yaş ortalaması 52,90 ± 6,02 yıl olan toplam 40 AK'li birey dahil edildi. Hastaların ağrı şiddeti, fonksiyonel mobilite düzeyleri, üst ekstremite fonksiyonelliği, depresyon semptomları ve dengesi Görsel Analog Skala, 6 dakika yürüme testi, Zaman kalk ve yürü testi, Kol, Omuz ve El Sorunları anketi, Beck Depresyon Ölçeği ve Berg Denge Ölçeği ile değerlendirildi. Sonuç değişkenlerinin hangi prediktör değişkeni açıkladığını belirlemek için çoklu regresyon analizi kullanıldı. **Sonuçlar:** Çalışma sonuçlarına göre denge düzeyi ile ağrı ($p<0,001$), fonksiyonel kapasite ($p<0,001$), depresyon ($p<0,001$) ve üst ekstremite fonksiyonelliği ($p<0,001$) arasında orta-yüksek seviyede anlamlı bir ilişki bulunmuştur. Ek olarak, istirahat ağrısı ($p<0,048$) ve fonksiyonel kapasitenin ($p<0,001$) dengenin prediktörleridir. **Tartışma:** Denge, ağrı ve depresyon düzeyindeki artışlardan olumsuz etkilenir ve istirahat halindeki ağrı düzeyi ve fonksiyonel kapasite, dengenin belirleyicileridir.

Anahtar Kelimeler: Denge; Fonksiyonel kapasite; Ağrı.

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Geliş Tarihi (Received): 17.07.2023; Kabul Tarihi (Accepted): 31.08.2023

Adhesive capsulitis is one of several conditions that present with pain and progressive limitation of active and passive range of motion in the shoulder. Both internal and external shoulder pathologies can cause stiffness and pain and treatment should address the specific anatomic cause (Leafblad, Mizels, Tashjian and Chalmers, 2023). Adhesive capsulitis is more common in women than men and in the non-dominant extremity, with the most common age of onset being 40-60 years. Although the exact prevalence and incidence in the Turkish society is about 3-4% of the population (Celik, Seckin, Kara, Camur, Kilinc and Akman, 2014). For bilateral involvement rates, such as 6% and 50%, there are quite different data. This occurs in 5 to 34% of the contralateral limb and 14% of the bilateral limb (Jacob et al., 2023).

Balance is defined as the ability to prevent body from falling, which is essential for maintaining body posture, especially when executing complicated daily activities. The balance and sensorimotor system consist of multiple subsystems that contribute to motor control; proprioception and kinesthesia are responsible for the sense of body orientation (Özüdoğru et al., 2023). It is well documented that a reduced sense of proprioception is associated with shoulder injuries such as shoulder instability, impingement, rotator cuff (RC) dysfunction and adhesive capsulitis (Fabis, Rzepka, Fabis, Zwierzchowski, Kubiak, et al. 2016).

The body segments are connected through joints and ligaments forming a kinetic chain that connects the whole body as a motor mechanism able to generate, sum, and transfer forces to the muscles responsible for the final action. (Muchaxo et al., 2023). There are many studies in the literature examining the relationship between upper extremity diseases and balance, and most of these studies focused on adult and pediatric hemiplegia (Balıkçı, Karatekin and Çelik, 2023; Malick, Butt, Awan, Ashfaq and Mahmood, 2022). Nevertheless, studies on the factors affecting balance in shoulder joint diseases are insufficient. However, studies conducted in different ages and pathologies have reported that age (Henry and Baudry, 2019), gender (Sekulic, Spasic, Mirkov, Cavar and Sattler, 2013), body mass index (Greve, Alonso, Bordini and Camanho, 2007), sleep state (Pu et al., 2015), and attention (Woollacott and Shumway-Cook, 2002) affect balance. In this context, the aim of our study will be to determine the independent predictors affecting balance in AC patients.

METHODS

Study Design

The study was carried out between January and February 2023, and ethics committee approval was obtained from Muş Alparslan University (decision number: 77293). Verbal consent was obtained from the study participants just before starting the study, and the study was conducted in accordance with the Principles of the Declaration of Helsinki. This is a cross-sectional study. Considering the findings of Tveita et al.'s study in which they examined the value of joint range of motion in patients with AC, a total of 30 individuals were included in the study with 80% power and 5% type 1 error (Tveitå, Ekeberg, Juel and Bautz-Holter, 2008), but with a 25% drop-out risk. A total of 40 people were included.

Participants

Participants in the study were patients diagnosed with AC who were referred to Kırşehir Ahi Evran University School of Physical Therapy and Rehabilitation for a physiotherapy rehabilitation program. Measurements of the patients were made before the rehabilitation started.

Patients were included in the study if they (1) were aged 18–65 years, (2) had been diagnosed with AC, characterized by limitation of passive external rotation of the affected shoulder to <50% of the contralateral shoulder and normal radiographic finding of the affected shoulder, (3) had severe pain and shoulder limitation for at least 3 months, and (4) were literate and able to understand verbal instructions in Turkish as well as provide written consent for participation.

Patients with shoulder joint fractures, arthrosis, cervical disc herniation, and additional musculoskeletal pathologies were excluded from the study.

Instruments

The sociodemographic data of the participants was collected during face-to-face interviews. Participants' balance, pain level, functional capacity, mobility, depression level, and upper extremity disability were evaluated by the same researcher (İC).

Outcome measurement

Balance

The balance level of the participants was evaluated with the Berg Balance Scale (BBS). The BBS assesses the ability to maintain balance in different positions, postural changes, and movements. On the scale consisting of 14 questions, each question gets a value between 0 and 4 points (0: unable to do, 4:

normal). A total score between 0 (dependent) and 56 (independent) is taken from the scale. When the literature is examined, it has been reported that BBS is a valid and reliable method for assessing balance ability (Qutubuddin et al., 2005; Steffen and Seney, 2008; Şahin, Büyükavcı, Sağ, Doğu and Kuran, 2013).

Pain level

The Visual Analog Scale (VAS), a valid and reliable method, was used to assess the pain levels of the participants included in the study VAS consists of a 10 cm line. A score of "0" indicates no pain, and a score of "10" indicates unbearable pain (Bijur, Silver and Gallagher, 2001). Participants were asked to mark their pain levels during activity and rest on the VAS scale, and the values were recorded in cm.

Functional capacity

The functional capacity of the participants was evaluated with the 6-minute walk test (6MWT). In the 6MWT, participants were asked to walk as far as possible in six minutes, and the walking distance was recorded in meters (m) (Morinder, Mattsson, Sollander, Marcus and Larsson, 2009).

Mobility

The mobility levels of the participants were evaluated with the timed up and go (TUG) test. For the TUG test, the participant is asked to sit with his back leaning on a 46 cm high chair, stand up without support, walk the marked three-meter area on the floor at normal speed, and turn back to sit on the chair, respectively. TUG test time is measured and recorded in seconds (Podsiadlo and Richardson, 1991).

Depression level

Beck depression scale (BDS) was developed to assess depression in adolescents and adults (Beck, Ward, Mendelson, Mock and Erbaugh, 1961). Adapted to Turkish by Hisli (Hisli, 1989). Each question is scored between 0 and 3 on the scale, which consists of 21 questions in total. The total score on the scale is between 0-63. A high score indicates a high severity of depression (Beck et al., 1961).

Disabilities of Arm, Shoulder and Hand (DASH) Questionnaire

The Disabilities of Arm, Shoulder and Hand (DASH) questionnaire was used to evaluate the effect of upper extremity disorders on functional status of the participants. DASH is a valid and reliable questionnaire adapted to Turkish that evaluates disability, activity limitations, leisure activities and work participation after upper extremity pathologies (Düger et al., 2006). The survey consists of 21 questions and each question is scored between 1-5. A high score indicates a negative impact on upper extremity functionality (Hudak et al., 1996).

Statistical Analysis

IBM's Statistical Package for Social Science (SPSS) for Windows package program was used to analyze the data. Normality of the data was evaluated by Shapiro-Wilk and histogram test. Due to the parametric nature of the data, sociodemographic and clinical evaluation data were given as mean±standard deviation, and the relationship between variables was evaluated with Pearson Correlation analysis. Linear Regression analysis was used to determine the predictors of balance in patients with AC. Significance level was set as $p < 0.05$.

RESULTS

The demographics were shown in Table 1 which indicates the mean age of the participants as 52.90±6.02 years, the mean 6MWT values were as 543.89±65.18, the mean VAS (rest) values were as 3.32±1.16 and the the mean BBS score was as 40.22±8.52.

The relationship of the variables with each other has shown in Table 2. Balance which was measured with BBS showed positive high correlation with 6MWT ($r = 0.804$, $p<0.001$), negative high correlation with BDS ($r = -0.726$, $p<0.001$), negative moderate correlation with VAS (rest) ($r = -0.523$, $p<0.001$), VAS (activity) ($r = -0.694$, $p<0.001$), TUG ($r = -0.579$, $p<0.001$) and DASH ($r = -0.576$, $p<0.001$).

Linear regression showed a significant correlation between VAS (rest) values and BBS values ($P<0.048$, B: 2.392), as well as between the 6MWT values ($P<0.001$, B: 0.086). Considering the results of the Linear Regression analysis, VAS (rest), VAS (activity), 6MWT, TUG, DASH, BDS explaining 65% of the variance were found as independent determinants of BBS ($p<0.05$, Table 3).

Table 1. Demographic and clinical characteristics of the participants.

		n			%
Gender	**Male**	22			55.0
	Female	18			45.0
Affected Side	**Right**	20			50.0
	Left	20			50.0
Dominant Side	**Right**	30			75
	Left	10			25
		X	**SD**	**Min**	**Max**
Age (year)		52.90	6.02	42.00	64.00
Height (cm)		166.40	8.44	152.00	187.00
Weight (kg)		74.15	9.64	49.00	98.00
BMI (kg/m^2)		26.87	3.76	16.95	36.32
VAS (rest)		3.32	1.16	2.00	6.00
VAS (activity)		6.30	1.71	3.00	9.00
6MWT (m)		543.89	65.18	388.50	649.00
TUG (seconds)		8.61	2.16	5.76	14.98
DASH (score)		39.13	13.20	10.00	70.00
BDS (score)		32.53	12.90	8.00	57.00
BBS (score)		40.22	8.52	16.00	52.00

SD: Standart Deviation, Cm: Centimeter, Kg: kilogram, m: meter, BMI: Body Mass Index, VAS: Visual Analog Scale, 6MWT: Six Minute Walk Test, TUG: Time up and Go test, DASH: Disabilities of Arm, Shoulder and Hand Questionnaire, BDS: Beck Depression Scale, BBS: Berg Balance Scale n: Number of participants X: Mean

Table 2. Correlation between BBS and other assessments.

		VAS (rest)	VAS (activity)	6MWT	TUG	DASH	BDS
BBS	r	-0.523	-0.694	0.804	-0.579	-0.576	-0.726
	p	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
VAS (rest)	r		0.709	-0.723	0.615	0.487	0.844
	p		**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
VAS (activity)	r			-0.731	0.668	0.721	0.854
	p			**<0.001**	**<0.001**	**<0.001**	**<0.001**
6MWT	r				-0.668	-0.571	-0.842
	p				**<0.001**	**<0.001**	**<0.001**
TUG	r					0.510	0.755
	p					**<0.001**	**<0.001**
DASH	r						0.625
	p						**<0.001**

VAS: Visual Analog Scale, 6MWT: Six Minute Walk Test, TUG: Time up and Go test, DASH: Disabilities of Arm, Shoulder and Hand Questionnaire, BBS: Berg Balance Scale, BDS: Beck Depression Scale, p < 0.001, r: Spearman correlation coefficient

Table 3. Linear regression model of BBS.

	B	SE	Beta	p
Costant	-1.779	16.722	-	0.916
VAS (rest)	2.392	1.301	0.327	**0.048**
VAS (activity)	-0.868	1.017	-0.175	0.399
6MWT	0.086	0.023	0.657	**0.001**
TUG	0.044	0.573	0.011	0.939
DASH	-0.05	0.089	-0.078	0.576
BDS	-0.172	0.192	-0.26	0.377

R=0.84, R2=0.70 , Adjusted R2= 0.65 B: understandardized regression coefficient, SE: Standart Error VAS: Visual Analog Scale, 6MWT: Six Minute Walk Test, TUG: Time up and Go test, DASH: Disabilities of Arm, Shoulder and Hand Questionnaire, BDS: Beck Depression Scale Formula: [BBS= -1.779 + (2.392 × VAS rest) + (-0.868 × VAS activity) + (0.086 × 6MWT) + (0,044 × TUG) + (-0.05 × DASH) + (-0.172 × BDS)] p < 0.05.

DISCUSSION

According to the results of this study, it was revealed that there is a significant relationship between balance with pain levels (rest and activity), functional capacity, depression levels, and upper extremity function levels in patients with AC. This shows that balance is negatively affected by increases in pain and depression levels. Also, the results show that pain level, upper extremity functionality, functional capacity, mobility and depression levels are effective on balance in patients with AC. In addition, resting pain intensity and functional capacity are predictors of balance.

It is known that postural stability oscillations increase as the severity of pain increases in studies on diseases causing chronic pain (Ruhe, Fejer and Walker, 2012). For example, Özüdogru et al. reported that there is a relationship between pain intensity and balance level in patients with chronic non-specific low back pain (Özüdoğru et al., 2023). However, no study examining the relationship between AC pain and balance has been encountered. In the literature, there are some studies evaluating balance in cases diagnosed with shoulder problems (Baierle, Kromer, Petermann, Magosch, & Luomajoki, 2013). There are studies expressing that pain-related factors affect balance (Baierle, Kromer, Petermann, Magosch, & Luomajoki, 2013; Horlings, Van Engelen, Allum, & Bloem, 2008; Ruhe et al., 2012). Pain, which creates sensory input disorders in the visual, somatosensory or vestibular systems, causes decreased balance control (Horlings et al., 2008). The effect of proprioception on balance is known. Individuals with shoulder pain have been shown to have deficits in proprioception and limb coordination (Baierle, Kromer, Petermann, Magosch, & Luomajoki, 2013). Eker et al. in their study examining the effects of pain intensity on balance, postural stability and fall risk in patients with shoulder pathology, they stated that shoulder pain affects balance parameters (Eker and Kaygısız, 2021). As in our study, resting VAS values were found to be associated with BBS. Baierle et al. compared individuals with shoulder pain and healthy individuals in terms of balance and postural stability. It has been shown that balance control and postural stability of individuals with shoulder pain are negatively affected compared to the healthy group (Baierle, Kromer, Petermann, Magosch, & Luomajoki, 2013). In this study, we concluded that VAS (rest) is an independent predictor of balance. This situation shows that balance ability should be studied in the physiotherapy program in individuals with adhesive capsulitis as well as in individuals with shoulder pain.

The function of the upper extremities and posture are interrelated systems and are necessary to gain control of the trunk and to improve the quality of the movements of the upper extremities. In this sense, developing postural control enhances upper extremity function; and upper extremity movements are also important in developing postural control, which facilitates trunk musculature (Ustinova, Goussev, Balasubramaniam and Levin, 2004). No enough study is observed on the relationship of pain, balance, and mobility in individuals with AC. Alshami et al. examined mobility and walking balance in individuals with chronic shoulder pain. Individuals with chronic shoulder pain, balance was evaluated with the Romberg test, and mobility and walking balance were evaluated with the timed one-leg stance test. As a result of this study, no significant difference was observed between the groups (Alshami and Alrammah, 2021). In our study, parallel to this study, TUG values were found to be correlated with balance scores and pain level.

We did not encounter any literature examining functional capacity in individuals with AC and shoulder pain. However, Fukuoka et al. found that slowed upper extremity movements were an important determinant of performance at 6MWT in elderly individuals with hyperkyphosis (Fukuoka et al., 2022). The literature on evaluating shoulder pain and exercise functional capacity in different populations is not sufficient. In this respect, this paper might contributes to the literature. In our study, a significant correlation was found between functional capacity, pain, balance, mobility, and depression levels in individuals with AC. In addition, functional capacity was found to be an independent predictoring factor for balance in patients with AC.

In a study examining the effect and relationship of depression and anxiety on pain and upper extremity functionality in people with frozen shoulder, it was seen that patients with depression and anxiety symptoms had higher DASH and VAS scores. In addition, DASH score was correlated with both anxiety and depression levels (Ebrahimzadeh, Moradi, Bidgoli and Zarei, 2019). Ding et al. in a study evaluating the effect of anxiety and depression in patients with AC, patients with depressive symptoms found more pain and upper extremity disability than patients without symptoms (Ding et al., 2014). In this study, it was found that upper extremity functionality was associated with pain and depression in patients with AC.

It is known that AC consists of four phases (initial

period, freezing period, frozen period, and thawing period). In the current study, the stage of AC patients was not questioned, and we can consider this as a limitation of the study. Future studies also need to question the stages of AC disease.

In this study, predictors affecting balance in AC patients were investigated. According to the results of the study, VAS (rest) and 6MWT were found to be independent predictors of balance in AC patients. Since the factors affecting balance in AC patients are interrelated and predictive of each other, they should be taken into consideration when determining evaluation and rehabilitation programs.

Ethical Approval

The study was approved by the Ethics Committee of Muş Alparslan University (Decision no: 77293).

Authors' Contribution

İsmail CEYLAN: design, analysis, data collection, writing; Mehmet CANLI: design, analysis, data collection, writing, editing; Şafak YUMUŞAK: design; writing, editing; Halil ALKAN: analysis, writing, editing; Anıl ÖZÜDOĞRU: analysis, editing

Conflicts of Interest Statement

None.

Acknowledgements

None.

Funding

No financial support was received from any institution or person during the study.

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