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RESEARCH

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Impaired dynamic balance and its association with shoulder external rotation in patients with frozen shoulder: a cross-sectional study

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Abstract

Background Frozen shoulder (FS) causes shoulder pain and limited range of motion, leading to functional deficits such as impaired balance, but the factors associated with balance in FS and differences from healthy individuals remain unclear. This study aimed to compare balance performance between FS patients and healthy controls and identify variables associated with balance using regression analysis.

Methods This cross-sectional study included 154 individuals aged 40–65, with 78 patients diagnosed with FS and 76 healthy controls. The static and dynamic balance of all participants was assessed using the Biodex Balance System. In the FS group, scapular dysfunction was assessed using the Lateral Scapular Slide Test, trunk control was evaluated using the Functional Reach Test, pain intensity was measured using the Visual Analogue Scale, pain duration and shoulder range of motion were also recorded. Independent Samples T-Tests were conducted to compare the groups, while Pearson Correlation and Simple Linear Regression Analyses were performed to identify factors associated with balance performance.

Results Dynamic balance was significantly impaired in individuals with FS compared to healthy controls (Dynamic Overall Stability Index [DOSI]: 3.44 ± 1.42 vs. 1.54 ± 1.08, MD 1.90 [95% CI: 1.51–2.30]; Dynamic Antero-Posterior Stability Index [DAPSI]: 3.29 ± 1.28 vs. 1.60 ± 1.10, MD 1.69 [95% CI: 1.30–2.07]; Dynamic Medio-Lateral Stability Index [DMLSI]: 3.18 ± 1.07 vs. 1.61 ± 1.03, MD 1.57 [95% CI: 1.23–1.90]; all $p < 0.001$). Regression analysis showed that external rotation angle (ERA) was a significant predictor negatively associated with DOSI (B= -0.046, 95% CI: −0.081 to −0.011, β= -0.290, $p = 0.010$), accounting for 8.4% of the variance observed.

Conclusions Dynamic balance is impaired in patients with FS compared to healthy controls, and shoulder ERA is a significant variable associated with DOSI.

Keywords Adhesive capsulitis, Balance, Frozen shoulder, Pain

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Introduction

Frozen shoulder (FS) is a pathology characterised by pain, stiffness and limited range of motion of the shoulder joint [1]. Although the prevalence of FS in the population is 2–5%, it is quite common in the 40–65 age group [2, 3]. These clinical features are associated with functional limitations that may affect overall movement performance [4].

FS pain at rest and in active and passive movements leads to restriction in joint range of motion and functional pathologies [5]. In particular, there is a decrease in shoulder elevation and external rotation joint range of motion [6]. External rotation has been shown to be the first movement affected in the pathological process and there is a continuous global loss of Range of Motion (ROM) as the disease progresses [7].

Although numerous studies have examined the relationship between upper extremity conditions and balance, most have focused on pediatric, neurological, lymphedema, or geriatric populations. Research specifically addressing balance characteristics in shoulder disorders remains limited [8–13].

Shoulder disorders primarily affect upper limb function, but emerging evidence suggests that they may also influence postural control and balance [13]. Studies in adults with rotator cuff tears or shoulder instability have shown altered muscle activation patterns and compensatory movement strategies that can affect dynamic balance [14]. Therefore, investigating balance in patients with frozen shoulder is clinically relevant, as shoulder dysfunction may lead to functional deficits beyond local joint limitations [13, 15].

A study investigating the biomechanical changes associated with FS and their potential impact on postural stability suggests that pain and limited range of motion in the affected shoulder may affect overall body balance by altering compensatory movements and muscle activation patterns [16]. In addition, a study by Kibler et al. highlights the importance of considering the broader impact of shoulder pathology on functional activities, including those related to balance [17]. It is suggested that addressing shoulder dysfunction may not only improve upper extremity function, but may also improve overall stability and postural control [17].

Dynamic balance depends on the integration of anticipatory postural adjustments, trunk–arm coordination, and sensory feedback. Shoulder pain and restricted range of motion may interfere with these control mechanisms, potentially leading to impaired dynamic postural stability, whereas static balance tasks impose lower demands on such adaptive processes [13, 18, 19].

Studies investigating the relationship between frozen shoulder and balance are scarce and show considerable heterogeneity [20]. Existing studies have largely focused on populations or conditions different from those of the present study, or have treated balance as a secondary outcome rather than a shoulder-specific impairment. Therefore, balance impairments specifically associated with frozen shoulder remain insufficiently understood. Moreover, the potential association between shoulder ROM, particularly external rotation, and dynamic balance performance has not been adequately explored in patients with frozen shoulder [13, 21, 22]. This study aimed to compare balance performance between patients with FS and healthy controls. We hypothesized that patients with FS would demonstrate impaired dynamic balance compared to healthy controls, and that shoulder external rotation range of motion would be a significant predictor of this impairment.

Methods

Study design

This descriptive cross-sectional study was conducted between November 2023 and July 2025 at Kirsehir Research and Training Hospital, Physical Therapy and Rehabilitation Clinic to investigate the balance characteristics of people with FS. The study was carried out in accordance with the Declaration of Helsinki, and ethical approval was obtained from the Kirsehir Ahi Evran University Faculty of Medicine Clinical Research Ethics Committee on 10.10.2023 (Decision Number: 2023-17/130). Participants were provided with verbal and written information about the purpose, duration, and procedures of the study, and all signed an informed consent form.

Study population

Patients admitted to the Physical Medicine and Rehabilitation Outpatient Clinic with complaints of shoulder pain were examined by an experienced physiatrist. Patients who were diagnosed with FS by physical examination, who met the inclusion criteria, and who agreed to participate in the study were included in the study. To support the diagnosis and exclude other shoulder pathologies, magnetic resonance imaging was also performed for all patients. The control group consisted of hospital and university staff. The control group was also assessed by the same physiatrist and confirmed by the country's health database as having no chronic disease affecting balance.

A total of 208 patients were initially screened, of whom 44 did not meet the inclusion criteria. Of the remaining 164 participants, 85 were allocated to the FS group and 79 to the control group. During the study, 7 participants from the FS group and 3 from the control group were lost to follow-up due to non-participation in the assessment. The final analysis included 78 FS and 76 control participants. Figure 1 presents the participant flow and reasons for exclusion.

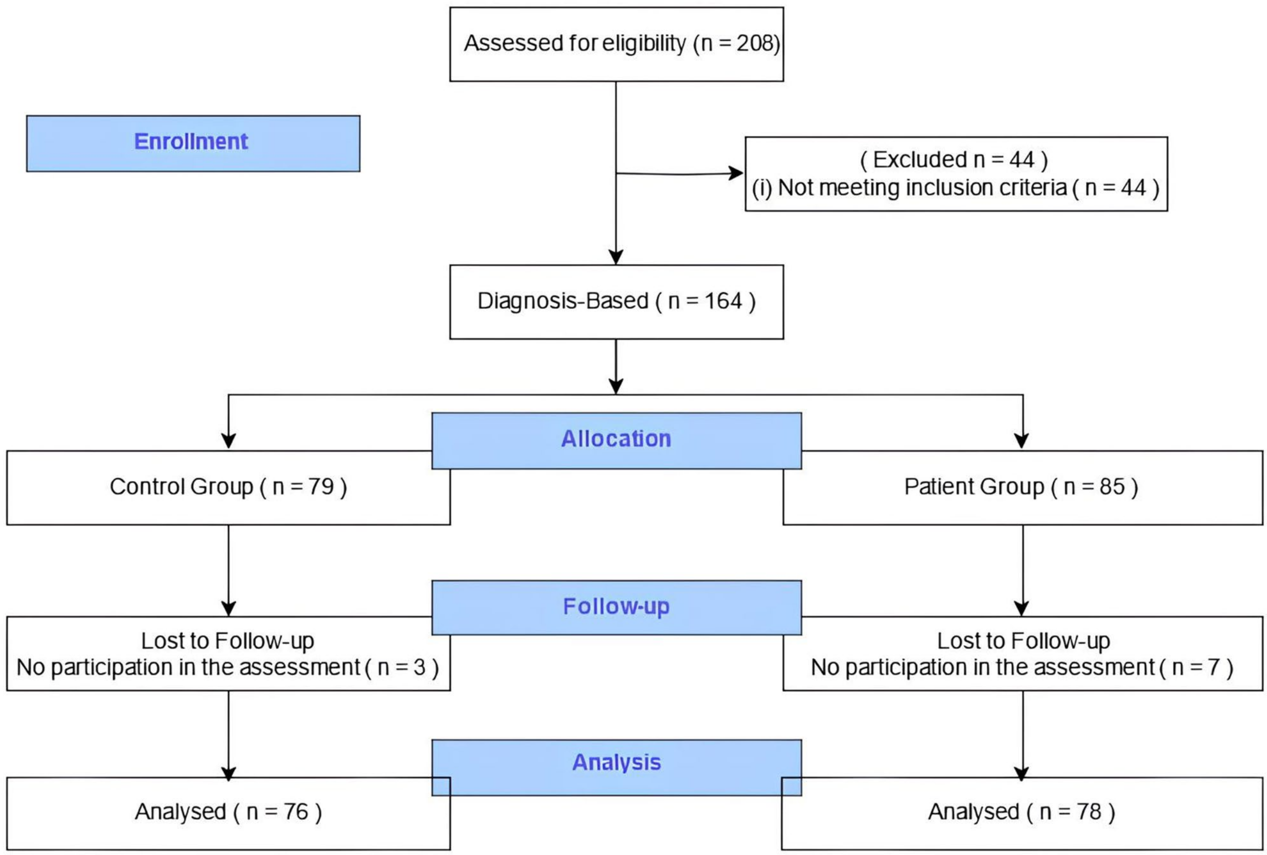

Fig. 1 Flow chart

Inclusion and exclusion criteria

This study included volunteers aged between 40 and 65 years who were diagnosed with unilateral FS, classified as stage 2 or 3, with pain persisting for more than 3 months, demonstrating at least 25% limitation in at least two planes of shoulder movement, cognitively intact and able to cooperate. Only patients diagnosed with primary (idiopathic) adhesive capsulitis were included. Individuals with neurological, rheumatic, cardiac, or active malignant diseases; a history of upper or lower extremity surgery, trauma, or fracture; significant scapular dyskinesis (≥ 1.5 cm side-to-side difference on the Lateral Scapular Slide Test); trunk control deficits (Functional Reach Test total score < 30 cm) and other comorbidities that could affect balance, including diabetes mellitus, thyroid disease, hypertension, obesity, chronic kidney disease, chronic pulmonary disease, and rheumatologic disorders, were excluded [18]. The control group consisted of healthy subjects aged 40–65 years who were not diagnosed with FS. Control participants were screened through face-to-face interviews, review of medical records, and confirmation from the national health database to ensure they were free from chronic conditions including diabetes mellitus, thyroid disease, hypertension, obesity, chronic kidney disease, chronic pulmonary disease, cardiovascular, neurological, or musculoskeletal disorders influencing balance. Controls were pre-specified to match the FS group in terms of age, sex, and Body Mass Index (BMI) to minimize confounding. Functional Reach Test and Lateral Scapular Slide Test were not performed in controls, as they were pre-screened to be healthy with no trunk or scapular dysfunction, and these tests were mainly used to exclude FS participants with deficits.

Sample size calculation

G*Power 3.1.9.7 (Heinrich-Heine-University Düsseldorf, Düsseldorf, Germany) was used to perform an a priori power analysis for the planned simple linear regression. Based on the relationship between pain intensity and dynamic balance, an effect size of 0.0406 was used [23]. With an alpha error probability of 0.05 and a desired statistical power of 0.95, the minimum required sample size was calculated as 77 participants. The final study sample satisfied this requirement, providing sufficient power to detect the hypothesized effect.

Data collection tools

Sociodemographic information of the patients included in the study, such as age, gender, height, weight, BMI, educational status, dominant side, comorbid status, and clinical information such as affected side, pain intensity, and pain duration were collected in a case report form by face-to-face interview. In addition, the patients' shoulder internal rotation angle (IRA), external rotation angle (ERA), flexion angle (FA) and abduction angle (AA) were measured using a digital goniometer. The pain intensity of the patients was measured using the Visual Analogue Scale (VAS); scapular dysfunction was assessed using the Lateral Scapular Side Test (LSST); trunk control was evaluated using the Functional Reach Test (FRT) and balance function was measured with the Biodex Balance System (BBS). All assessments were performed by a single trained assessor (Seher Dursun) following standardized procedures, with intra-rater reliability established prior to data collection for all outcome measures.

Biodex balance system

The Biodex Balance System (Biodex Medical Systems, Shirley, NY, USA) was used to objectively assess static and dynamic postural balance. The BBS consists of a mobile balance platform that can be tilted up to 20° and is connected to computer software that allows objective assessment of balance. With this system, the Anterior-Posterior Stability Index (APSI), the Overall Stability Index (OSI) and the Medial-Lateral Stability Index (MLSI) can be assessed. High values obtained from the test indicate a deterioration in balance and an increased risk of falling [24]. Participants were asked to stand barefoot on two legs on the platform, knees slightly bent (10–15º), eyes open, feet shoulder width apart, arms crossed over the chest and facing forward. Each test was performed 3 times for 20 s. The mean of the three trials was calculated for each participant. For dynamic balance, the platform stability level was set at 8 (on a scale from 12 [most stable] to 1 [least stable]), while for static balance it was fixed at 12. Participants rested for 30 s between trials to minimize fatigue. At the end of the test period, the OSI, MLSI and APSI parameters for both static and dynamic postural balance were recorded for all individuals.

Visual analog scale

Pain intensity was assessed using the VAS, which consists of a 10-cm line. Participants indicated their perceived pain during activity, ranging from 0 (no pain) to 10 (unbearable pain) [25].

Lateral scapular slide test

LSST was used to evaluate scapular dyskinesis. Bilateral measurements were performed at 0°, 45°, and 90° of shoulder abduction in three positions: arms at the side, hands on the iliac crest, and shoulders abducted with maximal internal rotation. The distance between the inferior scapular angle and the corresponding thoracic spinous process was measured, with a side-to-side difference greater than 1.5 cm considered indicative of scapular dyskinesis [26].

Functional reach test

Trunk control was evaluated using the FRT, which measures how far participants can reach forward without stepping. Participants raised their dominant arm to 90° flexion with a closed fist, and the distance between the starting and final position of the third metacarpal head was recorded. The test was repeated three times, and the mean of the last two trials was used. Scores ≤ 15 cm indicate high fall risk, 15–25 cm moderate, and > 25 cm low risk [27].

Range of motion assessment

Shoulder range of motion was measured using a digital goniometer following standardized procedures. Flexion and external rotation were assessed in the supine position, while abduction and internal rotation were measured in the seated position. Internal and external rotation were measured with the shoulder at 90° abduction and the elbow flexed to 90°. All measurements were performed actively, and the mean of two trials was used for analysis.

Statistics

All statistical analyses in the study were performed using the SPSS Statistics 26.0 package (SPSS Inc, Chicago, IL, USA). Categorical variables were analyzed using the χ^2 (Chi-square) test and are presented as numbers and percentages (%). Continuous variables were presented as mean and standard deviation (X ± SD), minimum and maximum values. The Kolmogorov-Smirnov test was used to determine if the data distribution was normal. Levene's test was used to assess variance homogeneity, and as variances were equal, the independent samples t-test was applied to compare the demographic and clinical characteristics of the patient and control groups. Among the multiple outcomes, the Dynamic Overall Stability Index (DOSI) was considered the primary outcome, while the Static Overall Stability Index (SOSI), Static Antero-Posterior Stability Index (SAPSI), Static Medio-Lateral Stability Index (SMLSI), Dynamic Antero-Posterior Stability Index (DAPSI), and Dynamic Medio-Lateral Stability Index (DMLSI) were treated as secondary outcomes to minimize the risk of Type I error. Pearson correlation analysis was used to determine the relationship between the dependent and independent variables of the patient group. Correlation coefficient value; a relationship between 0 and 0.25 is considered absent or weak, between 0.25 and 0.50 as a moderate relationship, between 0.50 and 0.75 as a high relationship and from 0.75 to 1.00 as a very high relationship [28]. Simple linear

Table 1 Baseline characteristics

Gender (male: female)	Patient Group ($n=78$)	Control Group ($n=76$)	*p*-value
	38:40	**31:45**	**> 0.05[b]**
Age (years)	54.08 ± 6.38	52.37 ± 5.02	> 0.05[a]
Weight (kg)	67.96 ± 13.87	69.09 ± 12.50	> 0.05[a]
Height (cm)	166.83 ± 9.36	168.42 ± 10.36	> 0.05[a]
BMI (kg/m^2)	24.23 ± 3.51	23.89 ± 3.05	> 0.05[a]
Dominant Side (right: left)	65:13	61:15	> 0.05[b]
Affected Side (right: left)	35:43	-	-
VAS (activity: rest: night)	2.47 ± 1.48: 4.23 ± 1.90: 2.65 ± 1.60	-	-
Pain Duration (months)	6.72 ± 2.43	-	-
Functional Reach Test (cm)	34.76 ± 0.96	-	-

VAS Visual Analog Scale, *BMI* Body Mass Index, [a]Independent samples t-test; [b]Chi-square test; *kg* Kilogram, *cm* Centimeter, *m* Meter

Table 2 Results and comparisons of balance assessment of groups

Variables	Patient Group (Mean ± sd)	Control Group (Mean ± sd)	t-value	*p*-value[a]	Cohen's d (95% CI)	Mean Difference (95% CI)
Static Overall Stability Index	0.93 ± 0.67	0.88 ± 0.72	-0.48	0.626	0.07 (−0.22–0.36)	0.05 (−0.15–0.15)
Static Antero-Posterior Stability Index	0.96 ± 0.88	0.74 ± 0.83	-1.58	0.116	0.25 (−0.06–0.55)	0.22 (−0.05–0.49)
Static Medio-Lateral Stability Index	1.02 ± 0.75	0.79 ± 0.91	-1.69	0.091	0.26 (−0.04–0.56)	0.23 (−0.04–0.50)
Dynamic Overall Stability Index	3.44 ± 1.42	1.54 ± 1.08	-9.55	**0.000**	1.53 (1.20–1.86)	1.90 (1.51–2.30)
Dynamic Antero-Posterior Stability Index	3.29 ± 1.28	1.60 ± 1.10	-8.71	**0.000**	1.45 (1.12–1.78)	1.69 (1.30–2.07)
Dynamic Medio-Lateral Stability Index	3.18 ± 1.07	1.61 ± 1.03	-9.18	**0.000**	1.56 (1.23–1.89)	1.57 (1.23–1.90)

SD Standard Deviation, [a]Independent Samples t Test; $p<0.05$

Table 3 Regression analysis of variables

Dependent Variables	Significant Independent Variables	B	SE	β	t	VIF	*p*	95% CI for B
Dynamic Overall Stability Index	Constant	5.486	0.786	—	6.978	—	< 0.001	3.920–7.052
	External Rotation Angle	-0.046	0.017	-0.290	-2.646	1.00	0.010	-0.080 – -0.011
	$R=0.290$; $R^2=0.084$; $F=7.00$; $p=0.010$							

B Unstandardized Regression Coefficient, *β* Standardized Coefficient, *SE* Standard Error, *VIF* Variance Inflation Factors, *= $p<0.05$; Model type: Simple Linear Regression

regression analysis was performed in the patient group to determine the effect of the independent variables on the balance parameters and to identify variables significantly associated with balance outcomes. Statistical significance level was considered as $p < 0.05$ and $p < 0.001$.

Results

The sociodemographic and clinical characteristics of the 154 participants (78 in the patient group and 76 healthy controls) are presented in Table 1. No statistically significant differences were found between the gender, age, weight, height, BMI, and dominant side of the study and control groups.

The results and comparisons of the balance scores between the groups are presented in Table 2. When the two groups were compared for SOSI, SAPSI, and SMLSI, no statistically significant differences were found. However, the patient group had significantly higher scores in the DOSI, DAPSI, and DMLSI compared to the control group ($p<0.001$ for all).

The correlation between the dependent and independent variables of the patient group is shown in Supplementary Table 1. A significant negative correlation was found between DOSI and ERA ($r=-0.290$, $p=0.010$).

The results of the regression analysis performed to detect the significant effect of independent variables on balance parameters in the patient group are shown in Table 3. ERA was significantly negatively associated with DOSI, accounting for 8.4% of the observed variance ($p=0.010$).

Discussion

The results of this study demonstrate that dynamic balance parameters were significantly lower in patients with FS compared to healthy individuals, while static balance remains relatively preserved. Additionally, shoulder ERA was significantly associated with DOSI, accounting for 8.4% of the observed variance. Moreover, the absolute mean differences in DOSI, DAPSI, and DMLSI (DOSI: 1.90 [95% CI: 1.51–2.30]; DAPSI: 1.69 [95% CI: 1.30–2.07]; DMLSI: 1.57 [95% CI: 1.23–1.90]) indicate large between-group differences in dynamic postural stability, which reflect altered dynamic balance performance rather than confirmed clinical deterioration. These differences are further supported by large standardized effect sizes (Cohen's d: 1.45–1.56), highlighting distribution-based variations rather than definitive clinical impairment. Therefore, the clinical relevance of these impaired dynamic balance indices in FS remains to be established, and future studies incorporating minimal clinically important difference (MCID), minimal detectable change (MDC), or prospective outcomes such as fall incidence are needed to determine their true clinical significance. These findings suggest that balance assessment may be considered in FS, and that balance interventions require further study. Although no established MCID exists for DOSI, the observed absolute mean differences represent statistically and distribution-based differences in dynamic balance parameters.

Although the pathophysiology of FS is not fully understood, it is thought to involve fibrosis of the joint capsule associated with synovial inflammation [29]. Histopathological studies have demonstrated elevated levels of inflammatory cytokines in the shoulder joint capsule and surrounding ligaments [30]. Pain arising from these inflammatory processes can limit daily activities and functional performance [30]. Previous literature indicates that pain negatively affects balance by altering sensory input from visual, vestibular, and somatosensory systems [12, 31]. Specifically, in individuals with shoulder pain, proprioceptive deficits and impaired upper extremity coordination have been shown to compromise postural stability [19]. Consistent with these findings, our study found that activity-related pain in FS patients was associated with poorer dynamic balance performance. Static balance, however, remained relatively preserved, suggesting that pain primarily affects dynamic postural adjustments. Evaluating pain as a separate variable using the VAS further clarifies its role in balance impairment.

Current clinical interventions for FS primarily focus on pain management and improving range of motion and include modalities such as electrotherapy, joint mobilization, pharmacological interventions, biopsychosocial approaches, and combinations thereof [32–34]. However, targeted interventions to enhance dynamic balance are rarely addressed in routine clinical practice. Although no balance intervention was implemented, the observed associations warrant investigation of balance-focused exercises in future interventional studies. Moreover, targeted exercises to preserve ERA may indirectly improve dynamic balance by maintaining compensatory movement capacity, although its direct functional contribution to dynamic balance requires further investigation.

The relationship between upper extremity and scapular function and trunk control is well established, as adequate trunk stability is necessary for the safe and efficient use of the shoulder, scapula, and upper extremity [15]. In our study, trunk control was assessed using the FRT, and scapular dysfunction was evaluated with the LSST. Patients exhibiting scapular dysfunction or impaired trunk control were excluded from the study. FRT and LSST findings further confirm that trunk and scapular function were preserved in our participants. Our findings indicate that trunk control is preserved in patients with FS, while dynamic balance indices are significantly impaired. These results indicate an association between dynamic balance deficits in FS and shoulder-specific movement limitations, while trunk control appears preserved, suggesting a potential interaction between shoulder function and trunk stability [15, 35].

Consistent with previous studies on shoulder kinematics, ERA has been reported to be significantly associated with dynamic balance in patients with FS [36]. Moreover, stiffness in the shoulder capsule initially limits external rotation, followed by abduction and internal rotation, potentially restricting compensatory strategies necessary for maintaining dynamic postural control [37]. Kinematic analyses have also shown that external rotation is the most affected movement in FS, which may further compromise dynamic postural control [38]. In contrast, other shoulder range of motion measurements such as internal rotation, abduction, and flexion did not differ significantly between FS patients and controls, which aligns with prior reports indicating that external rotation is the most selectively affected movement in FS [6, 36].

Our regression analysis indicated that shoulder ERA was significantly associated with dynamic balance parameters. This association may be theoretically explained by the interaction between shoulder mobility and trunk–shoulder coordination, which contributes to maintaining postural alignment and dynamic stability [17, 35]. When ERA is limited, efficient transfer of body weight through the lower limbs may be altered and associated with reduced dynamic balance performance [13, 15]. Nevertheless, other factors such as pain, proprioceptive deficits, and general shoulder stiffness may also contribute to postural instability, suggesting that ERA represents one of several interacting factors related to dynamic balance [19, 22]. This finding indicates a statistical association between ERA and dynamic balance; however, the underlying mechanism remains unclear. However, as dynamic balance was assessed with the arms crossed over the chest, the association between ERA and dynamic balance should be interpreted cautiously in terms of construct validity.

Taken together, these results indicate that altered dynamic balance, limited shoulder rotational range of motion, and activity-related pain in FS patients, which may be associated with limitations in functional performance. Clinicians may consider incorporating balance assessment into comprehensive evaluations of FS, while the effectiveness of balance-focused interventions should be established in future interventional studies.

Monitoring each variable separately (dynamic balance, static balance, ERA, pain, trunk control, and scapular function) allows for a more accurate understanding of patient-specific deficits and guides targeted interventions. Addressing both pain and postural control may help optimize treatment outcomes and reduce long-term disability in this population.

This study has several limitations. First, its cross-sectional design prevents the determination of causal relationships between shoulder range of motion, pain, and dynamic balance. Although our regression analysis showed that shoulder ERA is significantly associated with dynamic balance parameters, the cross-sectional nature prevents us from concluding that limited ERA causes impaired balance; the findings only indicate a statistical association. As no intervention was conducted, the findings reflect cross-sectional associations and do not provide evidence of intervention effectiveness. Second, the strict inclusion and exclusion criteria applied in this study may limit the generalizability of the results to the broader FS patient population. In particular, excluding individuals with significant scapular dyskinesis and impaired trunk control may have biased the FS group toward relatively better functional status, thereby reducing external validity and limiting the applicability of our findings to typical clinical populations. Third, due to the characteristics of our dataset, such as limited variance in some variables and violation of key assumptions for multiple regression, a valid multiple linear regression analysis could not be performed, and simple linear regression analyses were conducted instead. The absence of MCID/MDC values and prospective outcomes limits interpretation of the clinical significance of these findings. Additionally, these findings highlight the potential clinical importance of targeting ERA and dynamic balance in rehabilitation protocols, and underscore the need for longitudinal studies to further explore causal relationships and optimize therapeutic strategies. Fourth, the Biodex dynamic balance test was performed with arms crossed over the chest, minimizing upper-extremity movement and largely eliminating shoulder contribution. Thus, associations between ERA and dynamic balance should be interpreted cautiously. Future longitudinal or interventional studies are warranted to clarify causal relationships and to investigate whether targeted interventions such as external rotation exercises combined with balance training can improve dynamic balance and functional outcomes in patients with FS.

Conclusion

Patients with FS exhibited impaired dynamic balance compared to healthy individuals. Furthermore, shoulder ERA was statistically associated with dynamic balance parameters and accounted for a modest proportion of the observed variance; however, this association should not be interpreted as a direct functional or causal relationship, particularly under testing conditions that constrained upper-extremity movement.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

Conceptualization, A.T., İ.C. and B.Ç.K.; methodology, A.T. and B.Ç.K.; formal analysis, İ.C., A.T. and B.Ç.K.; investigation, A.T., Ö.F.Ö. and S.K.; data curation, S.K. and Ö.F.Ö.; writing-original draft preparation, A.T., İ.C. and S.K.; writing-review and editing, A.T., İ.C. and Ö.F.Ö.; supervision, B.Ç.K. and A.T.; project administration, B.Ç.K.; funding acquisition, S.K., Ö.F.Ö. and A.T. All authors have read and agreed to the published version of the manuscript.

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Data availability

The datasets analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Permission was obtained for the research from Kirsehir Ahi Evran University Faculty of Medicine Clinical Research Ethics Committee on 10.10.2023 (Decision Number: 2023-17/130). All participants provided written informed consent, and the study was conducted in accordance with the Declaration of Helsinki. Clinical trial number: Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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