Original Article

Official Journal of Erciyes University Faculty of Medicine

DOI: 10.14744/cpr.2023.53825
J Clin Pract Res 2023;45(6):565–74

Does Arthroscopic Rotator Cuff Repair Improve Kinesiophobia, Depression, and Spatiotemporal Parameters in the Long Term?

Gülnihal Deniz,[1] Furkan Bilek,[2] Ömer Esmez,[3] Arif Gülkesen,[4] Murat Gürger[3]

[1]Department of Physiotherapy and Rehabilitation, Erzurum Technical University, Faculty of Health Sciences, Erzurum, Türkiye
[2]Department of Gerontology, Muğla Sıtkı Koçman University, Fethiye Faculty of Health Sciences, Muğla, Türkiye
[3]Department of Orthopedics, Fırat University Faculty of Medicine, Elazığ, Türkiye
[4]Department of Physical Medicine and Rehabilitation, Fırat University Faculty of Medicine, Elazığ, Türkiye

ABSTRACT

Objective: This study aimed to investigate the long-term effects on pain, kinesiophobia, depression, functional capacity, balance, mobility, and spatiotemporal parameters in individuals who underwent rotator cuff (RC) surgery.

Materials and Methods: Measurements were conducted on 45 individuals recommended for RC arthroscopy. These included bilateral upper extremity range of motion (ROM), muscle strength, bilateral hand grip strength, spatiotemporal parameters, 9-hole peg test (9-HPT), Beck Depression Inventory (BDI), Tampa Scale of Kinesiophobia (Tampa), Shoulder Pain and Disability Index (SPADI), and Constant-Murley Score. All measurements were taken one week before and six months after the arthroscopic intervention.

Results: Post-RC arthroscopy results showed significant improvements in upper extremity ROM, muscle strength, hand grip strength, 9-HPT, Tampa, BDI, SPADI, and Constant-Murley Score compared to pre-arthroscopy measurements. Spatiotemporal parameters such as total weight transfer, step cycle duration, double stance duration, step length, gait cycle length, foot angle, and cadence values were highly significant in both operated and non-operated extremities after arthroscopic surgery ($p<0.01$). However, hindfoot pressure analysis and swing phase values were significant only on the operated side after arthroscopic surgery ($p<0.05$).

Conclusion: Prior to RC arthroscopy, individuals exhibited kinesiophobia, depression, reduced functional capacity, balance asymmetry, decreased mobility, and, consequently, spatiotemporal parameter asymmetry between the extremities. Gait disturbances (lengthened swing phase, decreased step length, increased foot angle), balance loss, and arm sway asymmetry were also evident before RC arthroscopy. Based on these findings, we suggest incorporating balance and gait training into the early rehabilitation program after RC arthroscopy.

Keywords: Rotator cuff, kinesiophobia, gait analysis, arthroscopy, balance.

Cite this article as:
Deniz G, Bilek F, Esmez Ö, Gülkesen A, Gürger M. Does Arthroscopic Rotator Cuff Repair Improve Kinesiophobia, Depression, and Spatiotemporal Parameters in the Long Term? J Clin Pract Res 2023; 45(6): 565–74.

Address for correspondence:
Gülnihal Deniz.
Department of Physiotherapy and Rehabilitation, Erzurum Technical University, Faculty of Health Sciences, Erzurum, Türkiye
Phone: +90 444 53 88 / 2740
E-mail:
gulnihal.deniz@erzurum.edu.tr

Submitted: 05.04.2023
Revised: 21.08.2023
Accepted: 17.10.2023
Available Online: 31.10.2023

Erciyes University Faculty of Medicine Publications -
Available online at www.jcpres.com

INTRODUCTION

The shoulder is the joint with the broadest range of motion (ROM). It is vulnerable to traumas because it is one of the most active joints in the body and plays a protective roll during falls. The functional state of this joint is primarily determined by rotator cuffs (RCs). The RC acts as the dynamic stabilizer of the glenohumeral joint.[1,2] Disorders related to RC are among the primary causes of shoulder-related pain and disability. If these RC defects are not addressed, can lead to the upward movement of the humeral head and the degenerative process in the shoulder, known as shoulder instability.[2] Both conservative and surgical treatments are available for RC tears.[2,3] Conservative treatment includes strengthening exercises, avoidance of painful movements, intra-articular injections, and the use of analgesic-anti-inflammatory drugs.[3] The goal of conservative treatment is to restore the compromised functions of the RC and alleviate pain. However, surgery is crucial for repairing the defects. Surgical techniques for RC tears are advancing swiftly both in our country and globally. Currently, arthroscopic interventions are the most popular approach. The preference for arthroscopic interventions has grown because of the benefits of smaller incisions, minimal impact on the deltoid muscle, reduced infection rate, and quicker postoperative recovery.[2] In daily life, the activity in which an individual is most mobile is walking. Studies have shown that arm swinging during walking enhances gait stability, improves balance, lowers energy consumption, and influences the spatiotemporal parameters of gait.[4] Literature also indicates that personal factors, such as kinesiophobia and tendencies toward depression, significantly affect the rehabilitation process, in addition to physiological factors.[5] Kinesiophobia, defined as an excessive and maladaptive fear of physical movement stemming from fear of painful injury or re-injury, often manifests after surgery. It can impede early recovery and contribute to the development of chronic pain. Therefore, identifying the presence and severity of kinesiophobia is crucial, as it has been linked to functional outcomes during the rehabilitation process.[5]

Gait anomalies are common in individuals with rotator cuff (RC) injuries both before and after surgery. These anomalies can result from pain, limited movement, kinesiophobia, and the use of assistive devices.[6] In light of these findings, the intention is to investigate functional capacity, kinesiophobia, depression, balance, and mobility in individuals who have undergone RC surgery.

MATERIALS AND METHODS

Participants

This study is both prospective and cross-sectional. The research population consisted of patients diagnosed with a rotator cuff injury at the Orthopedics Outpatient Clinic who underwent standard surgical procedures. The study sample comprised patients who met the inclusion criteria and consented to participate within the specified dates. A total of 57 patients were approached during the recruitment period, but the final sample size was reduced to 45 due to nine patients being excluded for not meeting the research criteria and three declining to participate. A post hoc power analysis was conducted using the G-Power 3.1.9.4 software to determine the adequacy of the sample size. The analysis revealed a high effect size of 0.5 and a power of 0.94 at a 95% confidence interval and a significance level of 0.05. These values indicate that the sample size is sufficient for the study.[7]

The inclusion criteria for the study were as follows: participants must be adults (over 18 years of age), have undergone arthroscopic surgical treatment for degenerative rotator cuff tear, be followed up by an orthopedist, and have a postoperative follow-up period of at least six months. Medical reasons such as shoulder instability, glenohumeral arthritis, cervical discopathy, previous shoulder surgery on the same side, rheumatoid arthritis, and a previous shoulder fracture were considered exclusion criteria.

This research received approval from the Institutional Review Board (IRB) of the authors' affiliated institutions. Following informed consent procedures, both verbal and written consent were obtained from all study participants in accordance with the Helsinki Declaration of Human Rights. The declaration was strictly adhered to throughout the study to ensure the protection of individual rights in research. This study was approved by Fırat University's Non-Interventional Clinical Research Ethics Board (approval number: 2022/04-27).

Assessment Tools

All measurements were taken one week before and then six months after the arthroscopic intervention. The bilateral upper extremity range of motion, bilateral upper extremity muscle strength, bilateral hand grip strength, spatiotemporal parameters (Fig. 1), 9-hole peg test (9-HPT), Beck Depression Inventory (BDI), Tampa Scale of Kinesiophobia (Tampa), Shoulder Pain and Disability Index (SPADI), and the Constant-Murley Score were measured for all participants before and after arthroscopic treatment.

Spatiotemporal Parameters: The Win-Track platform (MEDICAPTEURS Technology, France) is a tool used to measure both plantar pressure and gait parameters during barefoot walking. The platform's dimensions are 1500 mm×652 mm×30 mm (length/width/height).[8] As for the spatiotemporal parameters, total weight transfer, forefoot pressure analysis, hindfoot pressure analysis (Fig. 2), maximum plantar pressure, foot angle, step cycle duration, swing phase, step length, cadence, gait cycle distance, and double-support phase data were recorded.[9]

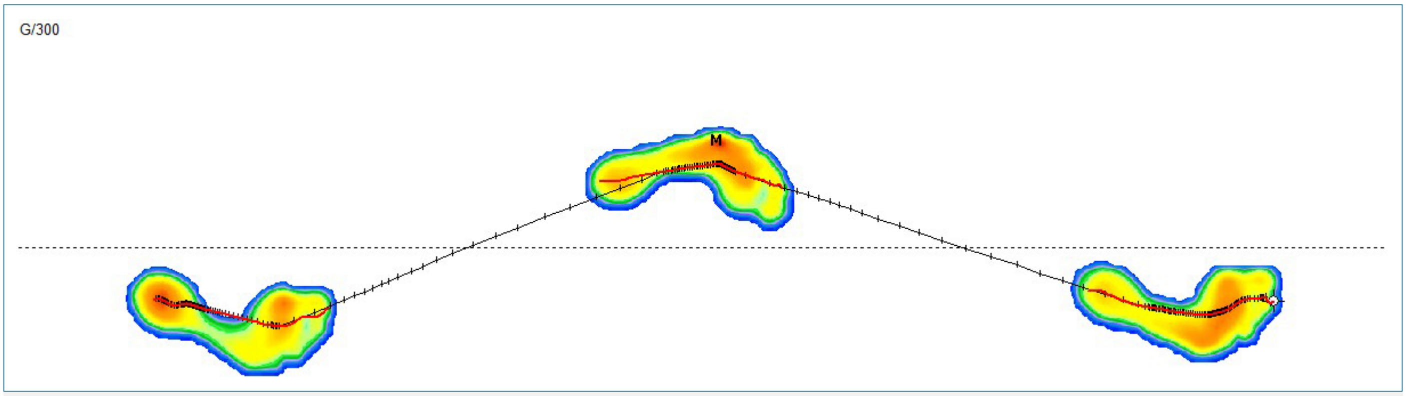

Figure 1. Analysis of spatiotemporal parameters.

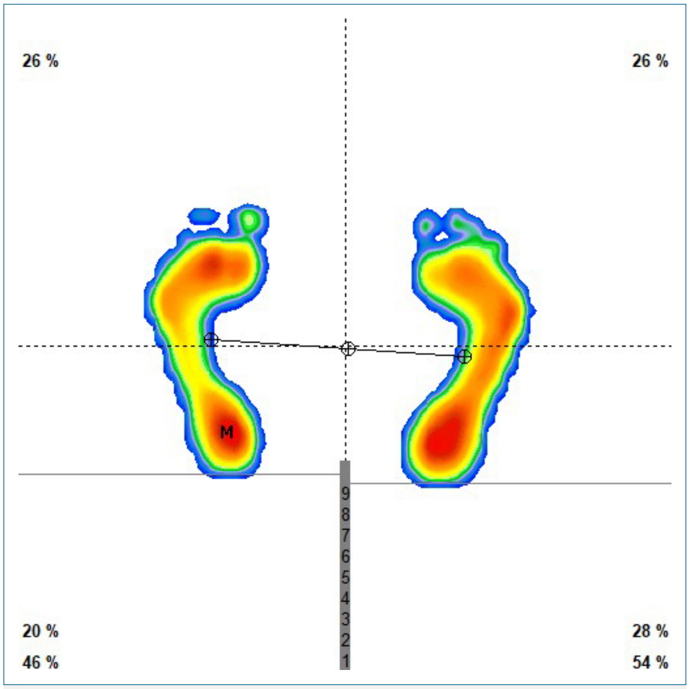

Figure 2. Analysis of total weight transfer, forefoot, and hindfoot pressure.

Hand Grip Strength Measurements: All measurements were taken on the operated and non-operated hands. An electronic hand dynamometer (HS-005, China) was used for handgrip strength assessment.[10]

9-HPT: This test is designed to evaluate upper extremity function and motor speed. During the test, the patient is required to insert nine nails, one by one, into nine corresponding holes and then remove them one by one without delay.[11]

BDI: The BDI is a self-report inventory comprised of 21 items that assess characteristic attitudes and symptoms associated with depression. Scores on the inventory are categorized as follows: ≤9 indicates no depression, 10–16 indicates mild depression, 17–23 indicates moderate depression, and ≥24 indicates severe depression.[12]

TAMPA: Scoring of this 4-point Likert-type scale evaluates the fear of movement: “strongly disagree” is 1, “disagree” is 2, “agree” is 3, and “strongly agree” is 4. The individual receives a total score ranging from 17–68.[13]

SPADI: This questionnaire consists of two parts, pain and disability, with a total of 13 questions. It is designed to rate pain and disability originating from the shoulder.[14]

Constant-Murley Score: Pain and activities of daily living are scored based on the patient’s self-assessment, while the clinician measures thes ROM and strength. The total score amounts to 100 points. 35% of the total score is subjective, and 65% is based on objective assessment. Scores between 100–90 points are rated as excellent, 89–80 points are good, 79–70 points are fair, and 69–0 points are poor.[15]

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 22.0 for Windows was used to analyze all study parameters. The normality of data was verified using Skewness and Kurtosis values, which should fall between −2 and +2 for normally distributed data. However, it was determined that the data did not adhere to a normal distribution. The Wilcoxon test was employed to evaluate the significance of binary parameters relative to each other. These findings suggest that the sample size is appropriate. Statistical values with $p<0.05$ were considered significant. The median of the 25–75 percentile was used to present continuous variables, while frequencies (n) and percentages (%) were used for categorical variables.

RESULTS

Analysis of Demographic Data

Out of the participants, 21 were women (46.7%), and 24 were men (53.3%). The mean age was 57.78±6.46 ($p>0.05$). Twelve participants (26.7%) were employed, while 33 (73.3%) were not. All participants were married. A total of 42 participants (93.3%) lived in the city, and 3 (6.7%) lived in the countryside. None of them used assistive devices. Nine participants (20%) were illiterate, 24 (53.3%) had completed primary school, 9 (20%) had finished secondary school, and 3 (6.7%) had undergraduate degrees.

Analysis of Measurements and Scales

This study thoroughly assessed the range of motion and muscular strength of the upper extremities. After the arthroscopic intervention, there was a significant increase in both the shoulder joint's range of motion and muscular strength across both extremities. The results showed a high level of statistical significance. Moreover, there was a noticeable improvement in the ROM for the elbow and wrist on the operated side and an increase in muscular strength. All these findings were statistically significant with $p=0.001$ and $p<0.01$ (Table 1). Additionally, evaluations including hand grip strength, 9-HPT, Tampa, BDI, SPADI, and the Constant-Murley Score showed significant improvement after the arthroscopic procedure compared to preoperative measurements. All these findings were statistically significant with $p=0.001$ and $p<0.01$ (Table 2).

Analysis of Spatiotemporal Parameters

Spatiotemporal parameters, including total weight transfer, step cycle duration, double stance duration, step length, gait cyle length, foot angle, and cadence values, were found to be highly significant in both operated and non-operated extremities after the arthroscopic surgery, with $p=0.001$ and $p<0.01$ (Table 2). Hindfoot pressure analysis was significant only on the operated side after the arthroscopic surgery with $p=0.04$ and $p<0.05$ (Table 2). The swing phase was highly significant only on the operated side after the arthroscopic surgery with $p=0.002$ and $p<0.05$ (Table 2).

DISCUSSION

Following RC repair, long-term expectations include significant functional improvements accompanying anatomical restoration. Post-surgery, factors that influence shoulder functionality have been particularly emphasized, and the long-term outcomes of functional recovery have been studies in various researches.[2,3] Ongoing investigations related to upper extremity muscle strength, upper extremity ROM, pain, depression, kinesiophobia, functional capacity, balance, and mobility persist, especially in the context of RC tendon injuries.[4,14] Besides the upper extremity, RC injuries also affect the lower extremity and walking.[6] However, there is often an oversight in long-term post-surgery follow-ups. In this study, factors such as pain, depression, kinesiophobia, ROM, muscle strength, balance, and gait were assessed both one week prior to the surgery and following a 6-month recovery period. The objective was to determine the efficacy of the surgery and the state of recovery. The rationale behind evaluating patients at the sixth month after the rotator cuff surgery stems from the typical recovery timeline, where return to work and normal daily activities usually takes place between 4–6 months after the procedure.[16]

Shoulder ROM

Shoulder ROM is a pivotal component of upper extremity functionality and serves as an objective measure of treatment response in shoulder injuries. Literature reviews have explored the angular requirements for daily living activities, revealing that many of these activities necessitate humeral elevation.[16] As a result, it has been determined that for individuals to perform daily tasks, shoulder flexion should be at 121°, abduction at 128°, external rotation at 90°, and internal rotation at 102°. In this study, we observed that these values were approached by the sixth month after surgery. In other studies, it was noted that there was an increase in ROM and muscle strength after the third month after surgery.[17] Consistent with the literature, this study showed a significant improvement in muscle strength and ROM on the operated side. It was determined that not only the shoulder's ROM circumference and muscle strength were affected due to the RC injury before arthroscopic surgery, but the elbow and wrist's ROM and muscle strength were also impacted. By the end of the sixth month postoperatively, active ROM, passive ROM, and increased muscle strength were detected in both extremities.

Grip Strength

Grip strength assessment is frequently used clinically to determine the difference in strength between the dominant and non-dominant arm or to compare it with normative values. Studies have indicated that grip strength is associated with overall upper extremity strength and function.[18] In this study, we observed that grip strength and upper extremity muscle strength were notably low before arthroscopic surgery and increased during recovery post-surgery.

The 9-HPT

The 9-HPT analysis is employed to evaluate upper extremity function based on performance.[19,20] In this study, consistent with the literature, values in the extremity with the RC injury were found to be higher than on the healthy side both before and after surgery. This further evidences the improvement in upper extremity function following RC surgery. According to the fear-avoidance model of musculoskeletal pain, widely

Table 1. Comparison of active and passive upper extremity range of motion and muscle strength measurements before and after arthroscopic surgery

	Side	Pre1W Median	Pre1W 25–75%	Post6M Median	Post6M 25–75%	p
Shoulder Flexion MSM	Operated	3	3–4	4	4–4.5	**0.001****
	Non-operated	4	4–4.5	5	4–5	**0.001****
Shoulder Extension MSM	Operated	3	3–4	4	4–4.5	**0.001****
	Non-operated	4	4–5	5	4–5	**0.001****
Shoulder Abduction MSM	Operated	3	2–4	4	3–4.5	**0.001****
	Non-operated	4	4–4.5	4.5	4–5	**0.001****
Shoulder External Rotation MSM	Operated	3	2–3	4	3–4	**0.001****
	Non-operated	4	3.5–4	4	4–5	**0.001****
Shoulder Internal Rotation MSM	Operated	3	2–3	4	3–4	**0.001****
	Non-operated	4	3.5–4.5	4	4–5	**0.001****
Elbow Flexion MSM	Operated	4	3–4	5	4–5	**0.001****
	Non-operated	5	4–5	5	4–5	**0.006****
Elbow Extension MSM	Operated	4	3–5	5	4–5	**0.001****
	Non-operated	5	4–5	5	4–5	**0.024***
Wrist Flexion MSM	Operated	5	4–5	5	4–5	**0.006****
	Non-operated	5	4–5	5	4–5	1
Wrist Extension MSM	Operated	5	4–5	5	4–5	**0.006****
	Non-operated	5	4–5	5	4–5	1
Shoulder Flexion ROM Active	Operated	60	50–170	155	115–175	**0.001****
	Non-operated	180	150–180	180	165–180	**0.001****
Shoulder Flexion ROM Passive	Operated	85	60–180	170	140–180	**0.001****
	Non-operated	180	160–180	180	170–180	**0.002****
Shoulder Extension ROM Active	Operated	20	0–40	40	30–50	**0.001****
	Non-operated	40	40–55	52	45–60	**0.001****
Shoulder Extension ROM Passive	Operated	25	10–40	45	40–55	**0.001****
	Non-operated	50	40–60	60	55–60	**0.001****
Shoulder Abduction ROM Active	Operated	45	30–140	138	100–170	**0.001****
	Non-operated	180	163–180	180	170–180	**0.001****
Shoulder Abduction ROM Passive	Operated	70	40–160	148	118–172	**0.001****
	Non-operated	180	170–180	180	170–180	**0.006****
Shoulder External Rotation ROM Active	Operated	30	15–40	60	45–60	**0.001****
	Non-operated	80	45–90	82	60–90	**0.001****
Shoulder External Rotation ROM Passive	Operated	40	18–50	72	55–78	**0.001****
	Non-operated	80	50–90	85	72–90	**0.001****
Shoulder Internal Rotation ROM Active	Operated	30	10–40	50	40–52	**0.001****
	Non-operated	65	48–70	68	55–70	**0.001****
Shoulder Internal Rotation ROM Passive	Operated	35	20–50	59	50–60	**0.001****
	Non-operated	70	50–70	70	60–70	**0.001****

Table 1 (cont). Comparison of active and passive upper extremity range of motion and muscle strength measurements before and after arthroscopic surgery

	Side	Pre1W Median	Pre1W 25–75%	Post6M Median	Post6M 25–75%	p
Elbow Flexion ROM Active	Operated	150	145–150	150	147–150	**0.002****
	Non-operated	150	150–150	150	150–150	**0.024***
Elbow Flexion ROM Passive	Operated	150	148–150	150	150–150	**0.007****
	Non-operated	150	150–150	150	150–150	0.083
Elbow Extension ROM Active	Operated	0	0–0	0	0–0	**0.014***
	Non-operated	0	0–0	0	0–0	**0.024***
Elbow Extension ROM Passive	Operated	0	0–0	0	0–0	0.083
	Non-operated	0	0–0	0	0–0	**0.024***
Elbow Supination ROM Active	Operated	70	70–80	80	70–80	**0.001****
	Non-operated	80	70–80	80	75–80	**0.006****
Elbow Supination ROM Passive	Operated	80	75–80	80	76–80	**0.002****
	Non-operated	80	75–80	80	75–80	**0.024***
Elbow Pronation ROM Active	Operated	80	70–80	80	70–80	**0.002****
	Non-operated	80	70–80	80	70–80	**0.002****
Elbow Pronation ROM Passive	Operated	80	70–80	80	70–80	**0.002****
	Non-operated	80	70–80	80	70–80	**0.007****
Wrist Flexion ROM Active	Operated	80	72–80	80	75–80	**0.001****
	Non-operated	80	70–80	80	76–80	**0.001****
Wrist Flexion ROM Passive	Operated	80	74–80	80	78–80	**0.001****
	Non-operated	80	70–80	80	76–80	**0.001****
Wrist Extension ROM Active	Operated	70	70–70	70	70–70	**0.002****
	Non-operated	70	70–70	70	70–70	**0.002****
Wrist Extension ROM Passive	Operated	70	70–70	70	70–70	**0.024***
	Non-operated	70	70–70	70	70–70	**0.006****

MSM: Muscle strength measurements; Post6M: Postoperatively at 6 months; Pre1W: Preoperatively at 1 week; ROM: Range of motion; *: P<0.05; **: P<0.01. The Wilcoxon test was applied.

discussed in the literature, misinterpretation of pain signals causes individuals to develop a fear of pain, movement apprehension, and avoidance behaviors. Furthermore, the biopsychosocial model of chronic pain suggests that psychological factors, like pain-related fear, can influence the onset and progression of pain and disability.

Kinesiophobia

Kinesiophobia is defined as the fear of movement resulting from chronic pain and injury. If persistent, it can lead to movement disorders, disability, and depression in the long term. Literature reports that kinesiophobia is associated with complaints in the arm, neck, and shoulder.[21] Studies have also reported that while kinesiophobia scores were high prior to RC arthroscopy, they decreased after surgery.[22] Similarly, in this study, kinesiophobia scores were elevated in the pre-operative phase but decreased during the post-operative period. This underscores the significant role of kinesiophobia in the healing process.

The BDI

Depression is common in RC injuries due to the significant pain experienced, and its assessment is conducted using the BDI analysis. While BDI scores were observed to be high prior to RC arthroscopy in various studies, they were noted to decrease considerably during the post-operative recovery period.[12] Similarly, in this study, moderate depression was detected pre-operatively, but post-opertaively, there was a significant decline in BDI scores.

Table 2. Evaluation of spatiotemporal parameters and evaluation scales before and after arthroscopic surgery

	Side	Pre1W Median	Pre1W 25–75%	Post6M Median	Post6M 25–75%	p
Forefoot Pressure Analysis % (SS)	Operated	24	21–26	25	20–25	0.966
	Non-operated	25	19–26	25	22–25	0.066
p		0.440		**0.045***		
Hindfoot Pressure Analysis % (SS)	Operated	28	25–31	26	25–28	**0.044***
	Non-operated	25	23–31	25	25–30	0.213
P		0.455		0.899		
Total Weight Transfer % (SS)	Operated	51	49–54	50	48–50	**0.001****
	Non-operated	49	46–51	50	50–51	**0.001****
P		**0.004****		0.173		
Maximum Plantar Pressure (g/cm^2)	Operated	1330	1170–1668	1422	1185–1710	**0.001****
	Non-operated	1394	1292–1563	1390	1258–1546	0.181
P		0.487		0.127		
Step Cycle Duration (ms)	Operated	660	610–740	630	550–670	**0.001****
	Non-operated	640	550–660	620	540–735	**0.001****
P		**0.013***		0.170		
Swing Phase (ms)	Operated	1470	1340–1650	1480	1365–1620	**0.002***
	Non-operated	1500	1260–1670	1460	1275–1650	0.748
P		0.170		0.222		
Step Length (mm)	Operated	445	414–492	485	440–529	**0.001****
	Non-operated	461	390–523	473	430–540	**0.001****
P		0.334		**0.015***		
Foot Angle (degrees)	Operated	6.01	3.01–14.04	4.89	2.54–8.96	**0.001****
	Non-operated	3.27	1.94–7.85	2.80	1.04–6.54	**0.001****
P		**0.001****		**0.001****		
Double Stance Duration (ms)	Operated	400	370–480	410	380–450	**0.001****
	Non-operated	410	400–480	400	380–430	**0.001****
P		**0.002****		0.583		
Hand Grip Strength (kg)	Operated	21	15–26	28	18–31	**0.001****
	Non-operated	26	22–32	31	24–33	**0.001****
P		**0.001****		**0.001****		
9-Hole Peg Test	Operated	25.32	19.56–28.10	20.47	17.46–21.48	**0.001****
	Non-operated	21.56	17.22–22.46	19.47	17.11–20.19	**0.001****
P		**0.001****		**0.003****		
Cadence (number/minute)	Operated	93.80	81.10–105.50	111.50	96.80–134.90	**0.001****
	Non-operated					
Gait Cycle Length (mm)	Operated	937	836–1000	914	830–960	**0.003****
	Non-operated					
Kinesiophobia Scale Tampa	Operated	55	52–58	24	21–34	**0.001****
	Non-operated					
Beck Depression Inventory	Operated	14	10–23	9	6–15	**0.001****
	Non-operated					
Shoulder Pain and Disability Index	Operated	83.07	69.23–93.07	13.84	11.53–26.15	**0.001****
	Non-operated					
Constant-Murley Score	Operated	24	16–53	86	73–91	**0.001****
	Non-operated					

Post6M: Postoperatively at 6 months; Pre1W: Preoperatively at 1 week; ROM: Range of motion; *: P<0.05; **: P<0.01. The Wilcoxon test was applied.

Constant-Murley Scale

In existing literature, the Constant-Murley scale is deemed the international gold standard for assessing the functional status of the shoulder. To the best of the authors's knowledge, most studies have found the Constant-Murley score to be low pre-operatively, but it generally increases post-operatively.[23,24] In this study, a low Constant-Murley score was observed in the pre-operative phase, likely attributed to pain and functional impairment. Conversely, in the post-operative phase, the Constant-Murley score was markedly higher, aligning with observed recovery.

The SPADI

The SPADI is an internationally recognized questionnaire designed to assess shoulder pain and dysfunction. In this study, consistent with the literature, SPADI scores were notably high prior to arthroscopic RC surgery. However, postoperatively, there was a significant decline in SPADI scores, aligning with the observed recovery.[25]

Spatiotemporal Parameters

To the best knowledge of the authors of this study, there are limited studies that have conducted gait analysis on individuals post-arthroscopic RC surgery. Arm swings during walking play a pivotal role in balance, mobility, and cadencen.[6] Individuals with RC injuries tend to have reduced arm oscillations. The swinging of opposing arms is integral to normal gait, engaging the shoulder girdle and upper torso. It is reported that arm swings during walking enhance gait stability, improve balance, reduce energy consumption, and influence the spatiotemporal parameters of the gait.[4] Recent studies suggest that an imbalance in arm swing can lead to decreased walking speed, a reduction in the direction, speed, and power of torque transferred from the trunk, an emergence of unbalanced and asymmetrical gait, and increased variability in spatiotemporal parameters.[26,27] In light of these studies, gait analysis was conducted before and after surgery on individuals with unilateral RC injuries in the current research. In the preoperative forefoot and hindfoot pressure analysis, there was not a significant difference between the pre-operative and post-operative periods or between the operated and non-operated sides. However, in the Total Weight Transfer analysis, a statistically significant difference was observed between the operated and non-operated sides before surgery. This difference was not significant after surgery. Moreover, a significant difference was noted in the intra-group comparison before and after surgery. The authors of this study believe that this change can be attributed to the successful surgical intervention and subsequent recovery. It is evident that the disparity between the operated and non-operated sides diminished after surgery. In both the Step Cycle Duration and Double Stance Duration analyses, there was a significant difference between the operated and non-operated sides pre-surgery, but this difference was not present after surgery. In this case, the authors of this study can conclude that by the sixth month after surgery, gait had returned to normal and the difference between the operated and non-operated sides diminisheed. In both the pre-operative and post-operative analyses within the group, there were highly significant differences in the Step Cycle Duration and Double Stance Durations. From these findings, the authors of this study conclude that gait anomalies are more common before surgery.

Bahrili and Topuz[4] evaluated gait analysis by placing healthy individuals in simulated positions of patients with shoulder problems. Individuals with simulated shoulder issues exhibited reduced stride length compared to those with normal arm sway. Dreyfuss et al.[28] immobilized the upper extremities in three different conditions and compared them to normal gait in healthy individuals, finding the step length to be reduced. Similarly, in this study, preoperative step length measurements were shorter than those taken after surgery. Moreover, in this study, the swing phase duration was found to be significantly longer in the pre-operative period than in the post-operative period. Measurements for Foot Angle and Gait Cyle Length were also found to be significantly greater in the pre-operative period compared to the post-operative period.

Based on these measurements, the authors of this study believe that arm oscillations were asymmetrical in the pre-operative period due to the RC injury. Trunk movements were restricted because the shoulder joint was in adduction, leading to reduced walking motion. There was impaired coordination between the lower and upper extremities, resulting in significant asymmetries in spatiotemporal parameters.

Furthermore, the observed asymmetries and deviations in gait parameters underscore the complex relationship between upper-body movements and lower-limb coordination during walking.[6] The reduced arm oscillations and constrained trunk movements observed in the preoperative phase might be attributed to compensatory mechanisms activated by the RC injury. These adaptations could have caused changes in weight distribution and movement patterns, affecting gait stability and energy efficiency.[28,29] The significant improvements observed in the postoperative period suggest a positive outcome from the arthroscopic RC surgery in restoring gait symmetry and overall functional mobility.[30] The decrease in step cycle duration and double stance durations after surgery emphasizes the importance of timely intervention and surgical management in addressing gait anomalies associated with RC injuries. The restoration of step length, swing phase duration, foot angle, and gait cycle length post-surgery demonstrates the potential to regain a more harmonious balance between upper body dynamics and lower limb kinetics. Collectively, these findings suggest that successful arthroscopic RC surgery not only alleviates shoulder-related issues but also helps restore a more balanced and efficient gait pattern, subsequently enhancing the individual's overall quality of life and physical performance.

This comprehensive gait analysis highlights the intricate relationship between upper body movement and lower limb coordination during walking. The observed asymmetries and deviations in gait parameters in individuals with unilateral RC injuries underline the influence of such injuries on gait symmetry, stability, and energy efficiency. The notable improvements in gait parameters post-surgery indicate the potential of successful surgical management to establish a more balanced and functional gait pattern. These insights contribute to a deeper understanding of the role of arthroscopic RC surgery in addressing shoulder-related issues and improving overall mobility and gait performance.

Strengths and Limitations of this Study

The strengths of this study include detailed analyses (upper extremity ROM, muscle strength, hand grip strength, 9-HPT, Tampa, BDI, SPADI, Constant-Murley score, gait analysis) performed on individuals for whom RC arthroscopy was recommended. It has been proven that balance and gait training, which provides a holistic correlation between the upper and lower extremities, should be included in the rehabilitation program during the post-operative period. This study has a few limitations. Firstly, variations in individuals' daily lives after RC surgery may have influenced our results. Secondly, the shoulder typically remains motionless for days after surgical interventions. Therefore, participants may have adopted different compensatory mechanisms. Not examining this factor may influence the consistency of our results. Thirdly, there was no analysis during the early post-operative rehabilitation period. The authors of this study believed that gait analysis might yield inaccurate results since there may be movement limitations due to the use of a velpeau bandage in the first month postoperatively. Consequently, gait analysis was not conducted during the early post-operative period in this study.

CONCLUSION

In conclusion, the findings from this gait analysis illuminate the multifaceted challenges individuals with RC injuries face in the pre-operative phase. The range of adverse effects experienced, such as pain, kinesiophobia, depression, and compromised functional capacity, does not only impact the shoulder region but also resonates throughout the body's kinetic chain. After RC arthroscopy, gait metrics improved, showcasing a reduction in the swing phase, an increase in step length, a decrease in foot angle, healing of balance, and symmetrical arm sway. Given these results, balance and walking training should be incorporated into the rehabilitation program after RC arthroscopy. Such interventions can address lingering asymmetries, enhance proprioceptive awareness, restore bilateral coordination, and encourage a more fluid and stable gait pattern. By understanding the extensive implications of RC injuries on gait mechanics and integrating holistic rehabilitation approaches, clinicians and practitioners can maximize postoperative outcomes, championing the revival of shoulder function and fostering comprehensive physical well-being and graceful movement.

Peer-review: Externally peer-reviewed.

Ethics Committee Approval: The Fırat University Non-Interventional Research Ethics Committee granted approval for this study (date: 17.03.2022, number: 2022/04-27).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Author Contributions: Concept – GD, FB, ÖE, AG, MG; Design – GD, FB, ÖE, AG, MG; Supervision – GD, FB, ÖE, AG, MG; Resource – GD, FB, ÖE, AG, MG; Materials – ÖE, MG; Data Collection and/or Processing – ÖE, MG; Analysis and/or Interpretation – GD, FB; Literature Search – GD, FB, ÖE, AG, MG; Writing – GD, FB, ÖE; Critical Reviews – GD, FB, ÖE, AG, MG.

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

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Sethi P, Fares MY, Murthi A, Tokish JM, Abboud JA. The long head of the biceps tendon: a valuable tool in shoulder surgery. J Shoulder Elbow Surg 2023; 32(9): 1801–11. [CrossRef]
2. Coban T, Demirdel E, Yildirim NU, Deveci A. The investigation of acute effects of fascial release technique in patients with arthroscopic rotator cuff repair: A randomized controlled trial. Complement Ther Clin Pract 2022; 48: 101573.
3. Danilkowicz R, Levin JM, Crook B, Long JS, Vap A. Analysis of risk factors, complications, reoperations, and demographics associated with open and arthroscopic rotator cuff repair: an analysis of a large national database. Arthroscopy 2022; 38(3): 737–42. [CrossRef]
4. Bahrilli T, Topuz S. Does immobilization of the shoulder in different positions affect gait? Gait Posture 2022; 91: 254–9. [CrossRef]
5. Wang H, Hu F, Lyu X, Jia H, Wang B, Liu F, et al. Kinesiophobia could affect shoulder function after repair of rotator cuff tears. BMC Musculoskelet Disord 2022; 23(1): 714.

6. Sonoda Y, Nishioka T, Nakajima R, Imai S, Vigers P, Kawasaki T. Use of a shoulder abduction brace after arthroscopic rotator cuff repair: A study on gait performance and falls. Prosthet Orthot Int 2018; 42(2): 136–43. [CrossRef]
7. Çapık C. Statistical power analysis and its use in nursing research: basic information. Anatol J Nurs Health Sci 2014; 17(4): 268–74.
8. Balgetir F, Bilek F, Kakakus S, Arslan-Tuncer S, Demir CF. Detection of ataxia in low disability MS patients by hybrid convolutional neural networks based on images of plantar pressure distribution. Mult Scler Relat Disord 2021; 56: 103261. [CrossRef]
9. Bilek F, Deniz G, Esmez O, Belhan O. Spatiotemporal parameters of the operated and non-operated knees before and after unilateral total knee arthroplasty. Gait Posture 2022; 91: 192–7. [CrossRef]
10. Deniz G, Kavakli A, Şikoğlu ÖK, Perilioğlu AZ, Yıldız E, Ögetürk M, et al. In patients with osteoarthritis and rheumatoid arthritis, effects of hand physical features on hand function. Kafkas J Med Scien 2021; 11(1): 68–75. [CrossRef]
11. Mathiowetz V, Weber K, Kashman N, Volland G. Adult norms for the nine hole peg test of finger dexterity. The Occupational Therapy J Res 1985; 5(1): 24–38. [CrossRef]
12. Beck AT, Steer RA, Carbin MG. Psychometric properties of the beck depression ınventory: twenty-five years of evaluation. Clinical psychology review 1988; 8(1): 77–100. [CrossRef]
13. Vlaeyen JWS, Kole-Snijders AMJ, Boeren RGB, van Eek H. Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. Pain 1995; 62(3): 363–72. [CrossRef]
14. Williams JW Jr, Holleman DR Jr, Simel DL. Measuring shoulder function with the Shoulder Pain and Disability Index. J Rheumatol 1995; 22(4): 727–32.
15. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res 1987; (214): 160–4. [CrossRef]
16. Kholinne E, Singjie LC, Marsetio AF, Kwak JM, Jeon IH. Return to physical activities after arthroscopic rotator cuff repair: a systematic review and meta-analysis. Eur J Orthop Surg Traumatol 2023; 33(6): 2645–54. [CrossRef]
17. Yazgan B. The investigation of factors related to performance and functional performance of the shoulder in long term after the artroscopic rotator cuff repair. Bolu Abant İzzet Baysal Üniversity, Thesis; 2019.
18. Horsley I, Herrington L, Hoyle R, Prescott E, Bellamy N. Do changes in hand grip strength correlate with shoulder rotator cuff function?. Shoulder Elbow 2016; 8(2): 124–9.
19. Temporiti F, Mandaresu S, Calcagno A, Coelli S, Bianchi AM, Gatti R, et al. Kinematic evaluation and reliability assessment of the Nine Hole Peg Test for manual dexterity. J Hand Ther 2023; 36(3): 560–7. [CrossRef]
20. Basar S. The ınvestigation of radiological findings and upper extremity functions in different age patients with degenerative rotator cuff tears. Gazi Sağlık Bilimleri Derg 2019; 4(2): 9–19.
21. Mengi A, Akif Guler M. Nocturnal pain in patients with rotator cuff related shoulder pain: A prospective study. Musculoskelet Sci Pract 2022; 59: 102536. [CrossRef]
22. Tokgöz MA, Ergişi Y, Odluyurt M, Ataoğlu B, Kanatlı U. The effect of pain catastrophizing and kinesiophobia on the result of shoulder arthroscopy. Agri 2021; 33(4): 232–6. [CrossRef]
23. Correia FD, Molinos M, Luís S, Carvalho D, Carvalho C, Costa P, et al. Digitally assisted versus conventional home-based rehabilitation after arthroscopic rotator cuff repair: a randomized controlled trial. Am J Phys Med Rehabil 2022; 101(3): 237–49. [CrossRef]
24. Vecchini E, Ricci M, Elena N, Gasperotti L, Cochetti A, Magnan B. Rotator cuff repair with single row technique provides satisfying clinical results despite consistent MRI retear rate. J Orthop Traumatol 2022; 23(1): 23. [CrossRef]
25. Hohmann E, Tetsworth K. Arthroscopic treatment and subacromial decompression of calcific tendinitis without removal of the calcific deposit results in rapid resolution of symptoms and excellent clinical outcomes in commercial airline pilots and cabin crew. Arch Orthop Trauma Surg 2023; 143(2): 919–26. [CrossRef]
26. Bailey CA, Hill A, Graham RB, Nantel J. Effects of arm swing amplitude and lower limb asymmetry on motor variability patterns during treadmill gait. J Biomech 2022; 130: 110855. [CrossRef]
27. Brooks LC, Weyand PG, Clark KP. Does restricting arm motion compromise short sprint running performance?. Gait Posture 2022; 94: 114–8. [CrossRef]
28. Dreyfuss D, Elbaz A, Mor A, Segal G, Calif E. The effect of upper limb casting on gait pattern. Int J Rehabil Res 2016; 39(2): 176–80. [CrossRef]
29. Kaiser TJ, Shanley E, Denninger TR, Reuschel B, Kissenberth MJ, Tolan SJ, et al. Preoperative screening in patients having elective shoulder surgery reveals a high rate of fall risk. J Shoulder Elbow Surg 2021; 30(7S): S84–8. [CrossRef]
30. Vervaecke AJ, Carbone AD, Abraham A, Bernstein Z, Laudier D, Verborgt O, et al. Tendon progenitor cells as biological augmentation improve functional gait and reduce scar formation after rotator cuff repair. J Shoulder Elbow Surg 2022; 31(11): 2366–80. [CrossRef]