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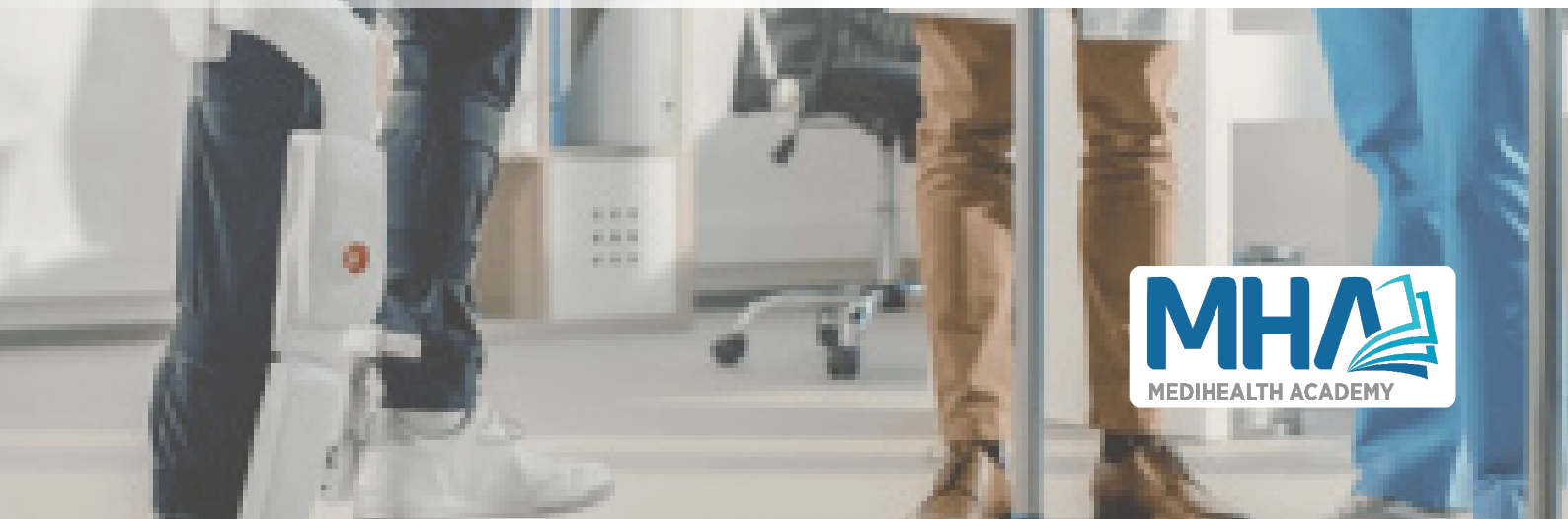

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Dear readers,

We are presenting the first issue of the Journal of Orthopedic Research and Rehabilitation in its 3rd year, meticulously prepared as always, for your appreciation and evaluation.

As an indicator of the academic quality of our journal, as we emphasize in almost every issue, our efforts to be included in qualified academic indexes continue.

Last year, we had four issues with 20 articles. These articles consisted of research articles, case studies and compilations. Most importantly, various branches of healthcare services contributed to the journal.

Therefore, we are very honored to share with you the information that we have started to see the beautiful results of our work that we have been continuing devotedly for almost three years.

As it is known, our journal has international indexes and we hope to be accepted into the TR Index database in the coming processes. Our authors, our valuable referees and our esteemed journal managers who never hesitate to provide the necessary support to the editorial group have a great share in this success.

As a result, we plan to see higher quality and more diverse studies in our magazine this year, as we do every year.

Best regards

Ayşe Gülşen DOĞAN

Editor-in-Chief

Journal of Orthopedics Research and Rehabilitation

Volume: 3 Issue: 1 Year: 2025

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ORIGINAL ARTICLES

REVIEW

Journal of Orthopedics Research and Rehabilitation

Original Article

DOI: 10.51271/JORR-0042

The effect of early mobilization on complications after chronic subdural hematoma surgery

Mustafa Cemil Kılınç, Emre Bahir Mete

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ABSTRACT

Aims: Chronic subdural hematoma is a common condition in the elderly population that often requires hospitalization. While some patients are discharged without surgery, others require surgical intervention due to symptoms such as loss of strength and consciousness. Preventing postoperative complications is as important as the surgical procedure itself. Early mobilization facilitates patients' return to routine daily life, thereby reducing complications associated with immobility. This study will examine the effect of early mobilization on postoperative complications.

Methods: This study included 34 patients diagnosed with chronic subdural hematoma who underwent surgical intervention at our institution between 2020 and 2024. Data collection encompassed findings from preoperative and postoperative neurological examinations, comorbid conditions, the extent of midline shift, time to postoperative mobilization, duration of intensive care unit stay, length of ward stay and overall hospitalization, as well as the incidence of postoperative complications. Patients in satisfactory general condition commenced oral feeding on the morning following surgery and were monitored under controlled conditions. The patients were divided into two groups: those who were mobilized and those who were not. These groups were then compared in terms of time to mobilization, postoperative complications, length of hospital stay, and mortality rates.

Results: A comparison of postoperative complications between mobilized and non-mobilized patients revealed a significantly lower incidence of complications in the mobilized group ($p<0.001$). Analysis of intensive care unit (ICU) stay duration ($p<0.001$) and total hospital length of stay ($p<0.001$) also indicated that both ICU and overall hospital stays were significantly shorter in the mobilized group. Mortality rates were notably higher in the non-mobilized group ($p=0.005$). Furthermore, when analyzing only the mobilized group, patients who experienced postoperative complications had a significantly later mobilization time compared to those without complications ($p=0.041$). A strong, positive correlation was also found within the mobilized group between the timing of mobilization and total hospital stay duration.

Conclusion: Early mobilization following chronic subdural hematoma surgery facilitate patients' reintegration into daily activities. Additionally, these measures minimize complications associated with immobilization and significantly reduce the length of hospitalization.

Keywords: Chronic subdural hematoma, early mobilization, postoperative complication, length of hospital stay

INTRODUCTION

Chronic subdural hematoma (CSDH) is commonly observed in the elderly population, with an estimated annual incidence of 58 cases per 100,000 individuals.[1] A 2011 study reported an annual incidence of CSDH of 80.1 cases per 100,000 individuals in those over 65 years of age, and 127.1 cases per 100,000 individuals in those over 80.[2]

While most patients experience favorable outcomes following surgery, postoperative mortality in CSDH ranges from 0% to 32%, with morbidity rates between 0% and 25%. However, recent data indicate that operative mortality generally ranges from 2% to 5%.[3,4]

Among the significant factors influencing mortality and morbidity, postoperative complications include focal brain injury, acute postoperative subdural or intracranial hemorrhage, seizures, surgical site infections, subdural empyema, and tense pneumocephalus.[5]

Postoperative medical complications, including pulmonary embolism, urinary tract infection, arrhythmia, ileus, cerebrovascular events, diabetes mellitus, and hypertension, are as critical as procedure-specific complications. In recent years, there has been a growing emphasis on studies aimed at preventing these medical complications, underscoring their

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significance.[6] In this context, early mobilization has gained critical importance and is now recognized as essential for preventing these complications and promoting functional recovery.[6,7]

Three primary surgical techniques are utilized in the treatment of chronic subdural hematoma: twist-drill craniostomy (TDC), burr-hole craniostomy (BHC), and craniotomy.[4,8,9] Although studies yield slightly varying conclusions, the prevailing consensus is that craniotomy is associated with a lower recurrence rate relative to the other techniques, albeit with higher morbidity and mortality. Conversely, TDC demonstrates the lowest morbidity and mortality rates but is linked to a higher recurrence rate. As a result, BHC is generally recommended, as it provides an optimal balance between efficacy and risk.[3,4,10]

This study will examine the effects of early mobilization on reducing postoperative complications in patients with chronic subdural hematomas treated using the BHC technique.

METHODS

Ethical Approval

The study was carried out with the permission of the Hitit University Erol Olçok Training and Research Hospital Scientific Researches Evaluation and Ethics Committee (Date: 05.04.2024, Decision No: 2024-08). We obtained an informed consent form from all patients for procedure. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Retrospective analysis was performed on patients who were hospitalized between January 2020 and September 2024.

Method

Cases of CSDH hospitalized between 2020 and 2024 were retrospectively reviewed using the hospital database. The study included 34 patients over the age of 65 who underwent unilateral CSDH surgery. Patients presenting with hemiparesis due to cerebrovascular diseases were excluded. Data on metabolic conditions such as diabetes mellitus, hypertension, anticoagulant use, and coronary artery disease were extracted from the database. Patients who underwent surgery were divided into two groups: those who were mobilized postoperatively and those who were not. The demographic characteristics of patients in each group, as well as preoperative and postoperative midline shift measurements, neurological examination findings, durations of intensive care unit stay, ward stay, and total hospital stay, postoperative complications, and mortality rates were recorded. Additionally, for patients in the mobilized group, the specific postoperative day on which mobilization occurred was noted (**Table**).

Table. Demographic characteristics and preoperative/postoperative data of the study groups

	Mobilized group	Immobilized group	Total
Number of patients	21	13	34
Age (mean)	78	84	80.38
Gender (female/male)	10/11	6/7	16/18
Preoperative hemiparesis	19 pateints	13 pateints	32 pateints
Postoperative hemiparesis	1 pateint	13 pateints	14 pateints
Preoperative midline shift (mean)	12.33 mm	15.08 mm	13.38 mm
Postoperative midline shift (mean)	5.62 mm	8.77 mm	6.82 mm
Length of ward stay (mean)	5.38 days	4.62 days	5.09 days
Length of ICU stay (mean)	1.38 days	8.23 days	4 days
Total hospital stay (mean)	6.76 days	12.85 days	9.09 days
Mortality	0	5 pateints	5 pateints
Postoperative complication	3 patients: 3 patients: Seizure	11 patients: 1 patient: Arrhythmia/ coronary artery disease 3 patients: Atelectasis 2 patients: Deep vein thrombosis 3 patients: Urinary tract infection 1 patient: Midline shift 1 patient: Seizure	14 patients
Mobilization time (mean)	1.9 days 1. day: 11 patients 2. day: 3 patients 3. day: 6 patients 5. day: 1 patient		

mm: Milimeters, ICU: Intensive care unit

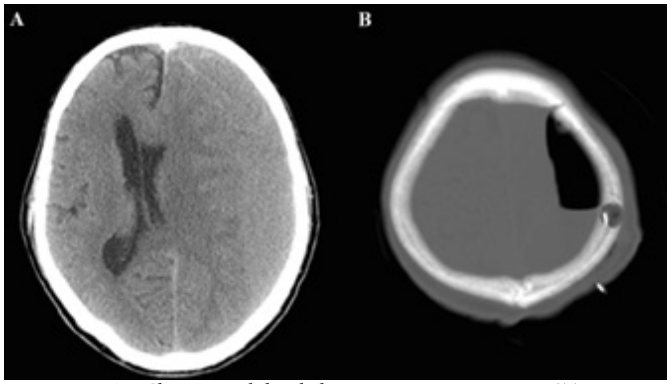

Figure 1. A: Chronic subdural hematoma preoperative CT scan, B: Postoperative CT scan burr hole craniostomy

CT: Computerized tomography

Surgical Procedure

Patients underwent surgery under sedation with local anesthesia via a single burr hole (**Figure 1**). Sedation was achieved using midazolam (0.01 mg/kg), fentanyl (0.5 mcg/kg), and propofol (1.5 mg/kg). Subdural drainage catheters were placed in all patients. For patients on anticoagulant or antiaggregant therapy prior to surgery, these medications were discontinued following cardiology consultation. Postoperative follow-up was conducted in the intensive care unit and the neurosurgery department.

Postoperative Management

Routine cranial computerized tomography imaging was performed on patients after surgery. Oral feeding of patients who were followed up in the ward after surgery was started the next morning. And patients who were provided oral feeding were walked in the ward corridor, which was approximately 30 meters long, in the morning and evening. Compression stockings were removed after walking. Patients with poor

general condition and hemiparesis before surgery were mobilized with wheelchairs. Subdural drains were removed from patients 48-72 hours after surgery. Cranial imaging was performed again after drain removal.

Statistical Analysis

Data analyses were conducted using the SPSS 22.0 software program for Windows. Descriptive statistics for numerical variables were presented as mean, standard deviation, median, and minimum-maximum values, while categorical variables were expressed as percentages and frequencies. Since the Shapiro-Wilk test indicated that quantitative data did not follow a normal distribution, non-parametric test procedures were applied. Specifically, the Mann-Whitney U test and Spearman's Rho correlation test were employed to assess relationships between parameters. The chi-square test was used for bivariate analyses of categorical variables. Results were evaluated within a 95% confidence interval, with a p-value of <0.05 considered statistically significant.

RESULTS

Of the 34 patients, 18 were male and 16 were female. Seven patients with good general condition postoperatively were transferred directly to the inpatient ward, while 27 patients were initially monitored in the intensive care unit before being transferred to the ward. Preoperatively, hemiparesis was present in 32 patients, with 19 in the mobilized group and 13 in the non-mobilized group. Postoperatively, improvement in hemiparesis was observed in 18 patients within the mobilized group. The average midline shift among all 34 patients was 13.38 mm preoperatively, which decreased to an average of 6.82 mm in the early postoperative cranial CT (computerized tomography) scans. The average total hospital stay and intensive care unit stay were 9.09 days and 4 days, respectively, with both durations being lower in the mobilized group. One patient undergoing anticoagulant therapy experienced rebleeding and required a second surgical intervention. During follow-up, epileptic seizures occurred in four patients, urinary tract infections developed in three patients, deep vein thrombosis was observed in two patients, and three patients exhibited atelectasis and respiratory distress. Mortality occurred in five patients (**Table**).

When the mobilized and non-mobilized groups were compared, the mobilized group showed a statistically significant reduction in postoperative complications ($p<0.001$). Similarly, when comparing the total hospital stay ($p<0.001$) and intensive care unit stay ($p<0.001$) between the two groups, statistically significant differences were found in favor of the mobilized group. When mortality rates were evaluated between the two groups, a statistically significant higher mortality rate was observed in the non-mobilized group ($p=0.005$).

Analysis within the mobilized group indicated that postoperative complications increased as the time to mobilization was further delayed ($p=0.041$). In the mobilized group, a significant, positive, and strong correlation was observed between delayed mobilization and increased total length of hospital stay (**Figure 2**).

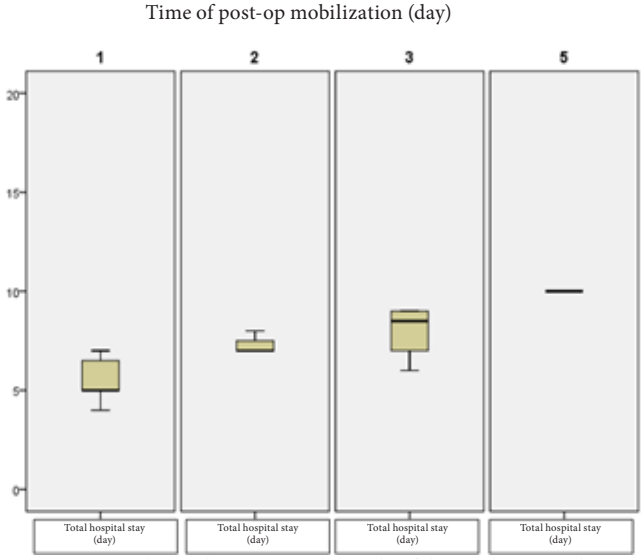

Figure 2. Correlation between total length of hospital stay and time to mobilization

DISCUSSION

Since CSDH is seen in the elderly population, there are many factors that affect the mobilization of patients. The most important factors are the amount of shift in the brain tomography before surgery and the patient's loss of strength during the examination. Performing surgery under sedation also plays an important role in early oral feeding and mobilization.[11]

In addition, the patient's relatives' support for the patient's nutrition and motivating the patient to walk are other important factors that accelerate mobilization. Patients who switch to oral intake early can also easily take their medications. Thus, monitoring of diseases such as diabetes and hypertension is easier. Deep vein thrombosis and pulmonary embolism are less common in patients who provide nutrition and start walking early. In addition, the rate of urinary tract infection is minimized in mobile patients who do not need a urinary catheter.[6]

Atelectasis is frequently seen in patients admitted to intensive care after surgery. Postural breathing exercises may not be given sufficiently to all patients in intensive care, and this increases respiratory distress.[12] In patients followed in the inpatient ward, psychological stress in the patient is reduced with the support of the patient's relatives. In patients with dysphasia, communication with their relatives contributes to the recovery of the patient.[13]

In the study of Adeolu et al.,[14] it was stated that early or late mobilization had no significant effect on postoperative complications. It was emphasized that pneumocephalus would increase and slow down the recovery in early mobilization. In support of this study, in our study, patients with less pneumocephalus and good general condition were encouraged to walk. Patients with severe headache, dizziness and tendency to sleep should not be walked.

In the study by Abouzari et al.,[15] it was stated that early mobilization would increase the rate of recurrent bleeding and had no effect on postoperative complications. In our study, no recurrent bleeding was detected due to early mobilization. Contrary to this study, late complications were less common in patients who were mobilized early.

Postoperative patient follow-up cannot be performed to the same standards in every center. This situation also affects the data in the studies. New studies emphasize the development of a new rehabilitation modality after chronic subdural hematoma surgery. Many parameters such as postoperative

patient position, antiaggregant and anticoagulant use, drain follow-up period, oral feeding process, patient mobilization should be included in new studies.[16,17]

The aim should not be only the timing of mobilization and early discharge. It is to standardize the patient's entire medical treatment with a holistic approach and to increase long-term survival. For this, multicenter studies with a large number of patients are needed.

Limitations
The limited number of patients constitutes the primary limitation of our study.

CONCLUSION
Early mobilization following CSDH surgeries should be considered an essential factor in reducing postoperative complications, hospital stay duration, and even mortality. Initiating mobilization as soon as possible facilitates the patient's reintegration into daily life. Further studies are needed to provide deeper insights into this subject.

ETHICAL DECLARATIONS

Ethics Committee Approval
The study was carried out with the permission of the Hitit University Erol Olçok Training and Research Hospital Scientific Researches Evaluation and Ethics Committee (Date: 05.04.2024, Decision No: 2024-08).

Informed Consent
Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process
Externally peer-reviewed.

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

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

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

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Journal of Orthopedics Research and Rehabilitation

Original Article

DOI: 10.51271/JORR-0043

Investigation of the relationship between functional tests and Low Back Pain Functional Scale in patients with chronic low back pain

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ABSTRACT

Aims: The aim of this study is to investigate the relationship between functional scales used to determine the functional level in patients with chronic low back pain and functional tests.

Methods: The study included 39 patients with chronic low back pain. We used the Low Back Pain Functional Scale (LBPFS) as a scale to determine the functional status of patients and the 5-repetition sit-to-stand test (5-RSTST) and timed up and go test (TUGT) as functional tests. Pearson correlation test was used for data analysis.

Results: There was a moderate negative correlation between the total score of LBPFS and 5-RSTST (r: -0.427, $p<0.007$), and a weak negative correlation between LBPFS and TUGT (r: -0.246, $p<0.05$).

Conclusion: LBPFS, which is used to determine the functional level in patients with chronic low back pain, has a moderate negative relationship with 5-RSTST and a weak negative relationship with TUGT. This result shows that LBPFS is insufficient to fully determine the function in patients with chronic low back pain and does not address all the parameters necessary to determine the function. The parts of the structure of LBPFS that are insufficient to determine the function can be reviewed to ensure that it determines the function more consistently. In this way, it is possible to determine the functional level more objectively with only one scale in patients with chronic low back pain who cannot perform functional tests or do not need to perform them.

Keywords: Chronic low back pain, Function Scale, Functional Test

INTRODUCTION

While low back pain is a major disability-causing problem in the world, it is known as the most common cause of absenteeism and the health problem that creates the greatest burden on health systems. Epidemiological studies have shown that 50-80% of people have experienced low back pain at some time in their lives.[1,2]

According to the World Health Organization (WHO), while back pain affected 600 million people in 2020, it is predicted that this number will exceed 800 million in 2050 due to the aging population, and the prevalence of back pain-causing disability is 7.2% worldwide.[3] One of the reasons why back pain reduces the quality of life of patients and causes disability is that it causes functional losses in patients.[4] Survey methods are frequently preferred to evaluate the functional losses commonly seen in patients with back pain, to determine their health status, and to evaluate the results of treatment.[5] However, the patients' pain, their attitudes towards re-injury, and their psychological state can influence these survey methods. Another method of determining functional losses or functional level in patients with back pain is physical performance tests. These tests generally include measurements aimed at completing a task. The patient's psychological state and attitude also influence physical performance tests, but research indicates that this effect is not as significant as the survey method.[6]

There are many scales in the literature used for the purpose of evaluating patients with low back pain, such as the Numerical Rating Scale, Pain Self-efficacy Questionnaire, Patient-Specific Functional Scale, Oswestry Disability Index, and Roland-Morris Disability Questionnaire.[7] Most scale validity and reliability studies were done in Turkish. The Low Back Pain Functional Scale (LBPFS) is the scale that specifically

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targets function as well.[7,8] While the RMDQ and the ODI are wide used, valid, and reliable scales for assesing low back pain, they have certain limitations. The LBPFS demostrates superior internal consistency, test-retest reliability, and sensitivity to change compared to the RMDQ, highlighting its advantages over the latter. Moreover, although the RMDQ and ODI are the most frequently utilized scales in research, they are insufficient in accurately reflecting the level of disability. Previous studies indicate that bhe LBPFS is more effective than RMDQ in detecting clinical changes in patients experiencing back pain for less than two weeks.[7] The previous studies indicate that LBPFS has some superiorties to apply in this study.[8] There are physical performance tests used to evaluate the functional level in patients with low back pain. The timed up and go test (TUGT) and the 5 repetition sit and stand test (5-RSTST) are easy to apply, valid, and reliable methods in terms of evaluating the functional status in patients with low back pain and providing objective information about the patient's functional level.[9] Although scales are widely used in evaluating the functional level in patients with low back pain, these scales are subjective assessments based on the personal statements of the patients. We believe that measuring the functional level with functional tests would be more objective. The use of functional questionnaires instead of physical performance tests may be more practical by saving time and equipment. Additionally, functional quastionnaires may be more reliable for determining functional levels in patients who have problems with balance. However, it has been observed that there is no study has been found examining the relationship between functional questionnaires and functional tests in chronic low back patients. Therefore, this study examines the relationship between LBPFS, which is used to determine the functional level in patients with chronic low back pain, and TUGT and 5-RSTST, which have proven validity and reliability

METHODS

Ethics

For this study, permission was obtained from the Gazi Yaşargil Training and Research Hospital Clinical Researches Ethics Committee (Date: 10.11.2024, Decision No: 238). Specialist physicians diagnosed patients with chronic back pain through clinical and MRI examinations, and provided them with detailed information about the study during interviews. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Design

The required sample size was calculated using the G*Power 3.1 programme based on an effect size of 0,5, an error probability of 0.05 and statistical power of 0.95. Effect size was determined based upon a medium effect of 0.5 which is calculated with the same programme.[10] The sample should have been composed at least 42 patients. However; during the 5-RSTST performing three of them did not want to finish the test because of increasing their pain. Therefore, we finished the study with 39 patients.

Patients included in the study were between the ages of 18-65 who with low back pain for the last three months. The study excluded patients who had surgery and physiotherapy in the last 6 months, back surgery, rheumatological diseases, cancer patients, pregnant women, those who had physiotherapy in the last 6 months, patients with acute radiculopathy, movement disorders, and hemiplegic patients.

Evaluations

Low Back Pain Functional Scale: Developed by Stratford and colleagues, it is a scale used to determine the functional level in patients with low back pain, and its validity and reliability have been proven. The validity and reliability of the Turkish version of the scale have been proven by Maraş et al.[8] The scale rates the patient's ability to perform daily housework, bend and squat, lift boxes from the floor, stand, and walk, with 12 items ranging from unable to perform to not difficult. The total score is evaluated between 0 and 60 points, and a higher score indicates that the patient's condition is better.[8]

Timed up and go test: This test was developed to demonstrate the functional status quickly and practically, and its reliability has been proven in patients with low back pain. The patient stands up from a sitting position on a backless chair and walks quickly to a marked location 3 meters away, then returns and sits back on the chair. The stopwatch is started when the test begins. The time from the beginning of the test to the time the patient places his/her hips on the chair is measured and recorded in seconds.[9]

Five Repetitive Sit-to-Stand Test: This test is a performance test, and its reliability has been proven in patients with chronic low back pain. The person is asked to sit in a standard chair with their arms crossed on their chest and is asked to sit down and stand up from the chair five times without changing their arm position. The performance time is measured with a stopwatch and recorded in seconds.[9]

These tests are easy to apply and not required many equipments and time to apply. These are the superiorities of this tests that we decided to use instead of the other functional test such as 6 minute walk test or 50 metre walking test. And also valid, and reliable methods in terms of evaluating the functional status in patients with low back pain and providing objective information about the patient's functional level.

Visual Analogue Scale (VAS): On a 10 cm horizontal line, the left starting point means no pain and the right end point means unbearable pain. The patient is asked to determine the intensity of pain. It is a measurement method with high reliability and validity in pain assessment.[11]

Statistical Analysis

The data of this study was made with the IBM® SPSS Version 21 program. In order to determine whether the data was normally distributed, normality analysis was performed. Since the values of skewness (0.506) and kurtosis (-0.552) were between +1.5 and -1.5, it was determined that the data was normally distributed.[12] Depending on this result, the Pearson test of the correlation test was selected. The coefficients' of Pearson test ranges from +1 (perfect positive corelation) to -1 (perfect negative corelation) with 0 indicate no corelation. Value of r means between .00-.19 very weak, .20-.39 weak, .40-.59 moderate, .60-.70 strong and .80-1.0 very strong.[13] As the second stage, the correlation analysis between LBPFS and TUGT and 5-RSTST was performed. The significant value was accepted as $p<0.05$.

RESULTS

Of the patients participating in the study, 30 were female (76.9%) and 9 were male (23.1%). The mean age of female patients was 38.5±7.5 years, the mean age of male patients was 40±6.3 years, and the mean age of all patients was 38.71±7.2 years (Table 1). In addition, 4 patients were single (10.25%) and 35 patients were married (89.75%). The mean of VAS was 5.589±2.17 and pain duration was 6.121±5.26 years.

Table 1. Demographic information of the patients included in the study

Gender	Age, mean±SD	n	%
Female	38.5±7.5	30	76.9
Male	40±6.3	9	23.1
Total	38.71±7.28	39	100

SD: Standard deviation

The correlation of between the patients' LBPFS total score and the TUG test was found (p>0.05 (r: -0.246) which was a weak negative correlation. It means LBPFS and TUG test result cannot give us similar results to assest of functional level of patient with low back pain. Therefore, LBPFS should not be preferenced to use instead of TUG test. The correlation of between the patient's LBPFS total score and 5-RSTS test was found (p<0.007 (r: -0.427) which was a moderate score. It means there is no strong relation between 5-RSTS test and LBPFS. However; LBPFS can be choosen instead of 5-RSTS test in some cases like patient can not achieve the physical performance tests (Table 2).

Table 2. Correlation between LBPFS and TUGT, 5-RSTST (new)

		LBPFS	
	Mean±SD	r	p
TUGT	9.36±1.85	-0.246	0.131
5-RSTST	16.64±4.107	-0.427	0,007
LBPFS	36.41±10.47		

LBPFS: Low Back Pain Functional Scale, TUGT: Timed Up and Go Test Pearson Correlation Test (r: +1 to -1) (p<0.05), 5-RSTST: 5-Repetition Sit-to-Stand Test, SD: Standard deviation

DISCUSSION

This study aimed to examine the relationship between LBPFS, a questionnaire assessment applied to patients with chronic low back pain, and TUGT and 5-RSTSTs, which are performance tests. According to the results we found, a moderate negative relationship was found between LBPFS and 5-RSTST, and a very weak negative relationship was found between TUGT.

Although the age range in our study was determined as 18-65, the age group was concentrated between 30-45. In order to adapt the study to the general, a more general comment can be made with a study in which equal patients from all age decades participated. One study that looked at the connection between different patient groups and functional tests was by Başar et al.[14] They looked at the connection between the Western Ontario Rotator Cuff Index and the 9 hole peg test to see how well patients with torn rotator cuffs could use their shoulders. They found that there wasn't a strong link between the scales and the tests. As a result of their study, they stated that scales and performance tests cannot be used interchangeably. Wijlhuizen et al.[15] examined the relationship between the scale used to measure disability and observation-based physical performance tests. As a result of the study, they stated that there was a weak-moderate relationship between the scale used to measure disability and observation-based physical performance tests.

Latham et al.[16] examined which of the self-report scales and physical performance tests would be more effective in determining physical function in patients with hip fractures. In the study, they used the Physical Mobility and Personal Care Scale, the 36-item short form Health Survey Physical Function Scale (SF-36 PF), and the physical functional performance test (PFP-10) as Self-Report Scales, as well as the short physical performance battery, 4-meter walking speed, and 6-minute walking test assessments for physical performance tests. As a result of the study, they stated that the sensitivity, validity, and responsiveness of self-report scales and physical performance tests gave similar results in patients followed up after hip fractures and that both could be used in clinical studies. They commented that picking the most appropriate functional measurement type for a clinical study would depend on the applicability of the measurement and the strength of the relationship between the study intervention method and a functional outcome measurement.

Lee et al.[6] They examined whether there is a relationship between self-reported activity limitations (e.g., walking, bending, getting up from a chair, putting on socks, and doing heavy work) and a functional performance battery consisting of six tests measured by the clinician in patients with low back pain. The Roland-Morris Disability Questionnaire was used to find out what activities people could not do and their lumbar flexion range of motion. The functional performance battery included a 15-meter walk at top speed, a 5-minute walk, 5 sit-to-stand repetitions, 10 trunk flexions, and a loaded reach task where patients reached forward while holding a weight equal to 5% of their body weight. They found a moderate relationship between the scale they used in the study and physical performance tests in patients with low back pain. The study results showed that measuring physical function solely through questionnaires or function tests based on physical performance would not be sufficient[5]. In this study, the LBPFS, which questions self-reports, and the TUGT and 5-RSTSTs based on physical performance were used to determine the functional levels of patients with chronic low back pain. Of these tests, TUGT was found to be very weakly correlated with LBPFS. TUG test inclued standing-up, walking, turning back and sitting down so it is a dynamic function. Patients must also maintain their balance while the TUG test is being performed. For this reason, correlation between LBPFS and TUG test can be weak correlatin. And also 5-RSTST was found to be moderate correlated with LBPFS. One of the reasons of this can be patient's physicology or level of understanding of reading as the LBPFS is a self-report scale. The other reason can be that 5-RSTS test can also be affacted by individual conditions such as pain.

Based on this result, we can say that using the 5-RSTST test or one of the TUGT instead of a subjective assessment method that questions the patient's self-reporting, such as LBPFS, in patients with chronic low back pain can provide more objective information about the functional level of the patients. Both of the tests used in the study are easy to perform, pose no risk to the patients, do not require a special environment, and can be completed in a short time.

Either 5-RSTST or TUGT can be selected to determine the functional level in patients with chronic low back pain. The results of Basar et al.,[14] Wijlhuizen et al.,[15] and Lee et al.[6] from the studies in the literature are consistent with the results of this study. These studies all agree that the relationship is either low, weak, or moderate. This weak-moderate relationship means that scales based on patient self-reporting are not capable of fully determining the functional level in chronic low back patients. We believe that it would be beneficial to improve the scales that measure the functional levels of chronic low back patients based on self-reporting in the future to provide results close to physical performance tests. The results of our study did not match those of the study conducted by Latham et al.[16] The difference between the study results may be due to the fact that the two studies were conducted on different patient groups. The scales used in the evaluation of hip fracture patients may have been prepared with a higher quality in determining physical performance.

Although the age range in our study was determined as 18-65, the age group was concentrated between 30-45. In order to adapt the study to the general, a more general comment can be made with a study in which equal patients from all age decades participated.

Limitations
Lack of diverse functional tests, concentration of the age range between 30-45, sample size not reaching sufficient number.

CONCLUSION
Instead of a subjective assessment method such as LBPFS, which questions the patient's self-report in patients with chronic low back pain, 5-RSTST or one of the TUGT can be used. The moderate correlation between LBPFS and 5-RSTST indicates that there are factors other than those questioned by LBPFS in determining the functional level in patients with chronic low back pain. This suggests that LBPFS is not fully sufficient to determine the functional level in patients with chronic low back pain. Expanding the LBPFS questioning framework and revising the existing questions may enable the scale to yield more objective results.

ETHICAL DECLARATIONS
Ethics Committee Approval
The study was carried out with the permission of Gazi Yaşargil Training and Research Hospital Clinical Researches Ethics Committee (Date: 10.11.2024, Decision No: 238).

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

Referee Evaluation Process
Externally peer-reviewed.

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

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

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

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Evaluation of COVID-19-related musculoskeletal pain in healthcare workers during the pandemic

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ABSTRACT

Aims: To investigate the prevalence, characteristics, and musculoskeletal distribution of pain, one of the most frequently encountered complications among healthcare professionals during the COVID-19 pandemic.

Methods: The study included healthcare workers who had recovered from COVID-19 at least six months before their inclusion. Demographic data of the participants were collected. Pain levels were assessed with the Visual Analog Scale. The "Oswestry Low Back Pain Disability Questionnaire" was used to measure low back pain and disability levels, which aims to assess how pain affects activities of daily living. The "Douleur Neuropathique 4 Questionnaire" interview section was used to assess the level of neuropathic pain.

Results: A total of 101 participants with a mean age of 37.72±1.22 years were included in the study. Of these participants, 78 (77.2%) were female and 23 (22.8%) were male. Of the participants, 32 (31.7%) were physicians, 34 (33.7%) were nurses, and 35 (34.7%) were healthcare workers. The most common areas of pain reported in healthcare workers in our study were the head, lower back, and back. A statistically significant difference was observed in the analysis of Oswestry Scores between different occupational groups ($p<0.001$). Subgroup analyses showed that there was no statistically significant difference between nurses and other healthcare personnel ($p=0.082$). However, a significant difference was observed between doctors and nurses ($p<0.001$) and also between doctors and other healthcare personnel ($p=0.008$). The most frequently reported neuropathic symptoms were numbness, pinprick sensations, and tingling.

Conclusion: Our study that examines the location and character of pain in the musculoskeletal system in healthcare workers can support fundamental strategies in the protection of healthcare workers and the continuity of healthcare system delivery. Developing necessary prevention strategies is crucial to prepare healthcare workers for managing future outbreaks.

Keywords: COVID-19, Visual Analogy Scale, Oswestry Low Back Pain Disability Questionnaire, healthcare professionals

INTRODUCTION

The COVID-19 pandemic, originating from the novel coronavirus SARS-CoV-2, is an unprecedented global health crisis. This virus was initially detected in Wuhan, China, in December 2019. Its swift transmission prompted the World Health Organization (WHO) to declare it a pandemic on March 11, 2020.[1] SARS-CoV-2 research studies are still relevant as one of the 20 most important and highest-rated research article topics of 2023.[2] Subsequently, the pandemic has developed into a persistent and complex issue with far-reaching consequences, affecting healthcare systems, economies, and societies globally.

According to the latest WHO data, the global tally of confirmed COVID-19 cases has reached a staggering 769,369,823 cases, with 6,954,336 reported fatalities.[3] These figures are subject to change as healthcare systems and governments continue to contend with the persistent effects of the virus.

COVID-19 can result in a broad spectrum of clinical manifestations, spanning from mild upper respiratory symptoms to multi-organ failure. During the illness and in its aftermath, various complications may emerge. Viral infections can alter mitochondrial function. Studies in the literature have shown that the presence of SARS-CoV-2 proteins in muscle fibers causes muscle pain, fatigue, and weakness due to atrophy and necrosis.[4-6]

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Pain is a prevalent complication among individuals recuperating from COVID-19, with approximately 46.6% of COVID-19 patients identifying pain as their primary grievance. Among these patients, 69.2% experience myalgia and arthralgia, while the remainder report pain in the form of headaches, back pain, lower back pain, chest pain, throat pain, and abdominal pain.[7]

A study conducted by Su et al.[8] provides a comprehensive overview of the three primary factors contributing to pain in COVID-19 patients. These include systemic inflammatory immune mechanisms, neuropathic mechanisms, and secondary factors associated with COVID-19 pathology or its treatment.

Neuropathic pain, in particular, has been recognized as a significant symptom associated with various viral infections, including the herpes zoster virus, human immunodeficiency virus (HIV), Epstein-Barr virus, cytomegalovirus, enteroviruses, and certain tropical viruses.[9] Furthermore, neuropathic pain has been documented in patients who have recuperated from severe acute respiratory syndrome (SARS), a member of the coronavirus family, with one study revealing that fatigue, widespread myalgia, depression, and sleep disturbances persisted for up to two years following SARS.[10,11]

Throughout the pandemic, which has had profound social, economic, and psychological ramifications worldwide, healthcare professionals have exhibited exceptional dedication to their duties. Notably, healthcare workers emerged as the occupation most significantly impacted by the COVID-19 pandemic, primarily because of their heightened risk of infection, substantial job-related stress, and the necessity for social isolation.[12]

Several previous studies have established a connection between the physical and psychological consequences experienced by healthcare workers during the COVID-19 pandemic. However, our study represents leading research as it is the first to compare the prevalence of painful sites and the nature of neuropathic pain patterns among healthcare workers. Our primary research objective is to examine the prevalence, characteristics, and patterns of musculoskeletal pain, a common complication among healthcare workers who have had and recovered from COVID-19 infection.

METHODS

Ethical Considerations

The study received ethical approval from the Dr. Abdurrahman Yurtaslan Ankara Oncology Health Application and Research Center Clinical Researches Ethics Committee (Date: 08.07.2021, Decision No: 2021-07/1285). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

This research was carried out by rigorous ethical standards, and informed consent was acquired from all participants. All necessary precautions were taken to safeguard the privacy and rights of the participants.

Study Design and Participants

This study employs a prospective cross-sectional design to examine the prevalence, characteristics, and distribution of pain within the musculoskeletal system in healthcare workers who have recuperated from COVID-19 infection. Information from healthcare workers who had COVID-19 was collected by telemedicine method with the approval of the Ministry of Health (Ministry of Health approval number: 2021-05-31T11_17_18) within the scope of pandemic measures. The collection date range of the survey data sent via SMS to healthcare professionals who had COVID-19 in line with the anamnesis taken from the patient: 10.07.2021-10.12.2021'dir. Age, gender, occupation, date of COVID-19 diagnosis, date of onset of pain, pain regions, pain intensity, duration, character, and pain with neuropathy character were recorded. One hundred fourteen patients participated in the study. 13 patients were excluded because they had chronic inflammatory pain. One hundred and one patients were evaluated. There were no health personnel working in the COVID ward or intensive care unit. A single doctor questioned the patients by telemedicine method, and informed consent forms were sent to the patients via e-mail.

The recovery criteria for COVID-19 infection align with the World Health Organization's guidelines, encompassing the improvement of all COVID-19 symptoms, the absence of fever for three consecutive days, and two consecutive negative nasopharyngeal swabs (verified through real-time reverse transcriptase-polymerase chain reaction) for SARS-CoV-2, with a 24-hour interval between them.[13] Health workers who had COVID-19 at least 6 months ago Healthcare workers aged 18 years and over who had COVID-19 at least 6 months ago were included in the study. The duration of recovery is measured from the moment when the patient met the recovery criteria to their enrollment in the present study. Participants with chronic inflammatory pain, a history of endocrine/metabolic diseases or malignancies, and those who had undergone spine or joint surgery before the pandemic were excluded from the study.

Assessment Methods

The study assessed the participants' pain levels using the Visual Analog Scale.[14] Neuropathic pain was determined by conducting interviews using only the "Douleur Neuropathique 4 Questions (DN4) Scale." In addition, the "Oswestry Low Back Pain Disability Questionnaire" was used to evaluate lower back pain and measure its effect on the participants' daily life activities.

The VAS Pain Score (Visual Analog Scale)

The study utilized the VAS Pain Score, which ranges from 0 to 10, to assess the participants' pain levels. On this scale, a score of 10 represents the worst pain, while 0 indicates no pain. Following the World Health Organization's pain intensity scale, pain scores below three were categorized as mild, between 3 and 6 as mild to moderate, and above six as severe.[15]

The Douleur Neuropathique 4 Questions (DN4)

The Douleur Neuropathique 4 Questions (DN4) is a screening test recommended by the International Association for the Study of Pain (IASP) for evaluating neuropathic and non-neuropathic pain. A review of the DN4 has shown a sensitivity of 83% and a specificity of 90%.[16] The initial seven questions in the DN4 are related to symptom assessment, covering sensations like burning, painful coldness, electric shock sensation, tingling, pins and needles sensation, numbness, and itching. In our study, we used these questions to assess neuropathic pain in healthcare workers who had recovered from COVID-19.

The Oswestry Low Back Pain Disability Questionnaire

The Oswestry Low Back Pain Disability Questionnaire was originally developed by Fairbank et al.[17] in 1980 to measure disability levels in individuals with lower back pain. It was later revised by Fritz and colleagues in 2001. This questionnaire assesses personal care, pain intensity, lifting, sitting, walking, standing, sleeping, pain change, social life, travel activities, and daily life activities. The minimum score that can be obtained from this scale is 0, and the maximum score is 50. The Oswestry score is calculated using the formula: (individual's score/possible maximum score) X 100. The interpreted percentage values are as follows:

- 0% to 20%: Lower back pain is not a significant problem in the individual's life.
- 20% to 40%: Lower back pain mildly restricts the individual's daily life.
- 40% to 60%: Lower back pain severely limits the individual's daily life.
- 60% to 80%: The individual's daily life is entirely restricted due to lower back pain.
- 80% to 100%: The individual is considered bedridden due to lower back pain. In this study, the Oswestry Score was calculated only for healthcare workers with lower back pain.

Data Collection

The data collection process received approval from the Ministry of Health, complying with pandemic control measures (Approval Number: 2021-05-31T11_17_18).

Data were collected using telemedicine methods and were obtained between July 10, 2021, and December 10, 2021. The following variables were documented for each participant: age, gender, occupation, date of COVID-19 diagnosis, date of pain onset, pain locations, pain intensity, duration of pain, character of pain, and the presence of neuropathic pain characteristics.

Statistical Analysis

The data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25. To assess the normality of data distribution, the Kolmogorov-Smirnov test was applied. Descriptive statistics were utilized to provide a summary of the data, with continuous variables presented as mean±standard deviation and, where appropriate, as median (minimum-maximum). Categorical data were expressed in terms of counts and percentages. Group comparisons for parametric variables were carried out through the independent student's T test and one-way ANOVA analysis. A significance level of $p<0.05$ was considered to indicate statistical significance in the results.

RESULTS

The study included a total of 101 participants, with an average age of 37.72±1.22 years. Among these participants, 78 individuals (77.2%) were female, while 23 individuals (22.8%) were male. It's noteworthy that out of the individuals who had previously recovered from COVID-19, 8 of them (7.9%) had to be hospitalized. The mean age of those patients who experienced severe pain requiring hospitalization was 48.62±3.73 years. For more comprehensive demographic and clinical information, please refer to **Table 1**.

Table 1. The demographic and clinical characteristics of the patients

Age (mean±SD) (min-max)	37.72±10.28 (20-58)		
F/M (n, %)	78 (77.2)/23 (22.8)		
Occupation (n, %):			
Physician	32 (31.7)		
Nurse	34 (33.7)		
Healthcare personal	35 (34.7)		
Hospitalization (n, %)	8 (7.9)		
Pain (n, %)	84 (83.2)		
Duration of pain (n, %):			
Less than 4 weeks	55 (64.6)		
4-12 weeks	20 (24.4)		
More than 12 weeks	9 (11)		
Pain regions and severity	**n**	**mVAS**	**VAS >7 (n, %)**
Headache	80	4.9	35 (34.6)
Lower back	78	4.69	35 (34.6)
Back	76	4.84	29 (28.7)
Legs	73	4.35	24 (23.7)
Arms	70	3.58	16 (15.8)
Neck	69	2.92	9 (8.9)
Shoulder	69	3.18	17 (16.8)
Chest	68	2.73	15 (14.8)
Knee	67	3.37	15 (14.8)
Elbow	66	3.07	14 (13.8)
Hip	64	3.50	14 (13.8)
Ankle	64	2.89	17 (16.8)

SD: Standard deviation, Min: Minimum, Max: Maximum, F: Female M: Male, mVAS: Median Visual Analog Scale

Regarding regions with the highest pain intensity (VAS 7≤), it was observed that the most common areas were the head 35 (34.6%) and the lower back 35(34.6%) out of 101 participants.

Out of the 47 participants (46.53%) aged 40 and above, 39 (83.0%) reported experiencing pain. Similarly, among the 54 participants (53.47%) aged below 40, 45 (83.3%) had pain. A statistical comparison of pain prevalence between individuals aged below 40 and those aged 40 and above revealed no significant difference ($p=0.963$).

Among the healthcare workers included in the assessment, 32 physicians were evaluated using the Oswestry scores. Of these physicians, 17 (53.1%) reported no significant back issues, 14 (43.8%) experienced mild limitations in their daily life activities, and only one person (3.1%) had severe restrictions in their daily life activities due to back problems. Out of the 34 nurses assessed, 5 of them (14.7%) did not report significant back issues, 16 individuals (47.1%) experienced mild limitations in their daily life activities, and eight nurses (23.5%) had severe restrictions in their daily life activities due to back problems. Additionally, five individuals (14.7%) were completely restricted in their daily life activities due to back problems. Out of the 35 healthcare personnel assessed, individuals (34.3%) had no significant back issues,12 individuals (34.3%) reported mild limitations in their daily life activities, 10 individuals (28.6%) experienced advanced restrictions in their daily life activities, one person (2.9%) was completely restricted in their daily life activities due to back problems.

When comparing Oswestry Scores among professional groups, a statistically significant difference was observed between the groups with a 95% confidence interval (F=9.858, p <0.001). In subgroup analyses, no statistically significant difference was found between nurses and other healthcare personnel (p=0.082), whereas a significant difference was noted between physicians and nurses (p<0.001) as well as between physicians and other healthcare personnel (p=0.008) Table 2.

Table 2. Oswestry low back pain disability questionnaire

	Not a significant problem	Mildly restricts	Severely limits	Entirely restricted	
All (n, %)	34 (33.6)	42 (41.5)	19 (18.8)	6 (5.9)	
Physician (n, %)	17 (53.1)	14 (43.8)	1 (3.1)	-	F=9.858, p<0.001*
Nurse (n, %)	5 (14.7)	16 (47.1)	8 (23.5)	5 (14.7)	
Healthcare personal (n, %)	12 (34.3)	12 (34.3)	10 (28.6)	1 (2.9)	

*ANOVA one way

When the Oswestry Low Back Pain Disability Questionnaire scores of individuals aged below 40 and those aged 40 and above were compared, there was no statistically significant difference found between the two groups within a 95% confidence interval (p=0.717)

When analyzing healthcare workers who experienced neuropathic symptoms following their COVID-19 infection, the three most common symptoms were tingling, numbness, and pins and needles sensation. The percentages of other neuropathic symptoms are detailed in Table 3.

Table 3. Douleur neuropathique 4 questions n (%)

Pins and needles	42 (41.2)
Numbness	35 (34.7)
Tingling	30 (29.7)
Painful cold	28 (27.7)
Burning	25 (24.2)
Electric shock	15 (14.9)
Itching	8 (7.9)

No statistically significant differences were found in any of the neuropathic symptoms when comparing individuals aged below 40 with those aged 40 and above (p>0.05).

DISCUSSION

Many studies show that pain in healthcare workers during the pandemic is higher than in the general population.[18] One study demonstrated a fourfold higher infection rate among healthcare workers compared to non-healthcare workers.[19]

In the literature, studies indicating an increase in the incidence of early pain after COVID-19 have frequently observed.[20-22] In studies, the most common pain areas/types are generally listed as headache, lower back, and back pain. A study conducted in Ireland on healthcare workers who had recovered from COVID-19 identified headache as one of the most common presenting symptoms among cases.[23] Another study on healthcare workers, which is in line with our study, found that headache was one of the most common symptoms, with a prevalence of 29.6%.[24] A study by Alomar et al.[25] supporting our findings identified lower back pain as the most common complaint among healthcare workers affected by COVID-19. In a retrospective study conducted by Lim et al.[26] on 609 COVID-19-infected healthcare workers, common pains were observed as musculoskeletal pain 19.2%, headache 14.8%. In a research article by Madani et al.,[27] they found a 22.9% rate of headaches in healthcare workers infected with COVID-19.

In our study, healthcare workers affected by COVID-19 were found to experience headaches, lower back pain, and back pain most frequently. This could be attributed to healthcare professionals performing various tasks, such as staying in the same position for long periods, working in shifts, and lifting and carrying patients, which may have contributed to a higher prevalence of lower back pain even before the COVID-19 pandemic.

In a study conducted on healthcare workers during the pandemic, 43 (27.2%) of 158 healthcare workers had a VAS of 7 and above (severe).[28] In our study, we observed that the regions with a VAS of 7 and above were the head and lower back, 35 (34.6%).

Studies conducted in the literature on COVID-19 cases have identified that 13.8% of cases required hospitalization due to severe disease activity, and 6.1% had critical illness requiring intensive care.[29] Our study is in line with the literature, as a small number of 8 patients (7.9%) required hospitalization in the COVID ward. Another study in the literature, which supports our findings, reported a hospitalization rate of 3.7% among healthcare workers under 40 years of age, while the hospitalization rate was 16.2% among healthcare workers aged 40-60.[30]

In our study, the most common neuropathic symptoms were pins and needles and numbness. In particular, physicians had lower disability scores compared to other healthcare professionals, and this difference was statistically significant among healthcare professionals in the Oswestry Low Back Pain Disability Questionnaire. In a study evaluating neuropathic pain using DN4 in patients who had recovered from COVID-19, symptoms such as numbness (42.2%), electric shock (37.8%), burning (33.3%), tingling (15.6%), and needle-like sensations were identified.[31] Our study aligns with the literature as it found a high prevalence of symptoms like numbness, along with a significant presence of needle-like sensations and tingling among healthcare workers.

One of the strengths of our study is that it is the first study to examine the character, regional prevalence, and distribution in the musculoskeletal system of pain in healthcare workers during the pandemic. Additionally, to the best of our knowledge, our study is the first to use the Oswestry Low Back Pain Disability Questionnaire on healthcare workers who have recovered from COVID-19.

Limitations

There are some limitations of our study, such as the small sample size, the inability to evaluate the examination part of DN4 in this study conducted through telemedicine, the fact that the majority of the participants were women, and the study had a cross-sectional design without specific pain assessments, the source of pain and its relationship with COVID were not determined.

CONCLUSION

After the pandemic, many neurological and musculoskeletal system problems have arisen among healthcare personnel that cannot be definitively attributed to the secondary effects of COVID-19. Particularly, this study that examines the location and character of pain in the musculoskeletal system in healthcare workers can support fundamental strategies in protecting healthcare workers and the continuity of healthcare system delivery. Developing necessary prevention strategies is crucial to prepare healthcare workers for managing future outbreaks. Further research with larger sample sizes and comprehensive assessments is needed to better understand the long-term effects of COVID-19 on musculoskeletal pain in healthcare workers and to develop effective management strategies.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Dr. Abdurrahman Yurtaslan Ankara Oncology Health Application and Research Center Clinical Researches Ethics Committee (Date: 08.07.2021, Decision No: 2021-07/1285).

Informed Consent

All patients signed and free and informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

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

Author Contributions

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

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Original Article

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Which arthroplasty option is superior in hip off-set reconstruction?

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ABSTRACT

Aims: Femoroacetabular offset (hip off-set) plays a very important role in hip joint stability. In this study, it was aimed to determine whether the three different surgical procedures used in total hip arthroplasty (THA) applications have any superiority over each other in terms of femoroacetabular offset restoration.

Methods: This study included 220 patients of 249 hips who underwent THA procedures performed by the senior author. These patients were divided into three groups. Group 1 operated with conventional femoral stems, group 2 operated with short femoral stem and group 3 operated with metal-on-metal hip resurfacing. Femoral off-set, acetabular off-set and hip off-set were measured individually by using pre-operative x-Ray and immediate post-operative x-Ray of all patients.

Results: There were 70 hips in group 1, 84 hips in group 2 and 95 hips in group 3. The measurement results of the short-stem THA group were significantly higher than those of the other groups. Groups pre-operative/post-operative femoral offset; for group 1 32.7±7.5/37.7±8.5 mm, for group 2 35.7±9.7/37.0±8.4 mm and for group 3 36.8±8.9/41.8±8.4 mm. Groups pre-operative/post-operative total offset; for group 1 123.8±9.5/120.7±10.5 mm, for group 2 127.3±17.1/122.9±16.6 mm and for group 3 130.3±14.3/129.7±10.3 mm. When the differences between groups in the changes in the pre-op and post-op offset values were examined, it was found that there were only differences between the femoral measurement results and that the increase of the offset values in group 2 was statistically significantly smaller than that of the other groups.

Conclusion: Short femoral stem THA or hip resurfacing arthroplasty is a better option for femoral offset reconstruction.

Keywords: Hip offset, femoroacetabular offset, short femoral stem, hip resurfacing, conventional femoral stem

INTRODUCTION

Hip osteoarthritis is one of the most common diseases worldwide.[1] It is caused by the cartilage of the hip joint being damaged, which may lead to pain and limitation of movement. Total hip arthroplasty (THA) can change the joint surface, reduce pain, and restore joint function.[2] THA is a successful surgical procedure that improves patients' quality of life and offers satisfactory long-term survival rates.[3,4] The increase in the world's population and life expectancy will lead to an increase in the number of patients undergoing THA and the expectations from this surgical procedure.[5] Despite innovations in both surgical techniques and implant technology over time, the revision burden of the procedure has remained roughly the same.[6] Aseptic loosening, wear, and dislocation are among the most common reasons for revision THA surgery.[7]

Femoroacetabular offset consists of the two components of femoral offset and acetabular offset. Femoral offset is the horizontal distance between the center of rotation of the femoral head and the femoral shaft, while acetabular offset is the horizontal distance between the midline of the pelvis and the center of rotation of the femoral head.[8] In the past, femoroacetabular offset reconstruction was ignored in THA surgery, but recent studies have shown that femoroacetabular offset plays a very important role in hip joint stability.[9] Failure to reconstruct the femoroacetabular offset in accordance with the natural hip structure may restrict the range of motion of the hip and increases the risk of dislocation.[9] In addition to these problems, inadequate offset reconstruction may cause gait disorders due to problems in the gluteal muscle group.[10]

Advances in materials engineering have led to improvements in osteointegration and the use of cementless THA is increasing.[11] Short stems, conventional stems, and hip resurfacing are frequently used in cementless THA applications. Surgeons have high experience with conventional femoral stems due

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to their good long-term results.[12] However, conventional stems have limited femoracetabular offset reconstruction capability because their design limits placement options.[12] Short-stem THA procedures are becoming more common day by day.[13] Short-stem arthroplasty procedures are reported to reconstruct the hip anatomy better than conventional-stem arthroplasty procedures.[14] And short femoral stems also ensure preservation of bone stock.[12] Another alternative to hip arthroplasty options is hip resurfacing arthroplasty, which is a particularly useful surgical procedure for young and active individuals.[15] The advantages of hip resurfacing arthroplasty over other methods are lower dislocation rate, better postoperative range of motion, and a gait pattern that is closer to normal.[16]

The authors believe that short femoral stems reconstruct the femoroacetabular offset better in light of the data in the literature, so this study aimed to compare the ability of 3 different hip arthroplasty options to reconstruct the femoroacetabular offset and to contribute to the literature for patient-specific implant selection.

METHODS

This study was approved by the Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee (Date: 19.12.2022, Decision No: EK-No. 1239/2019). Due to the retrospective design of the study and the fact that it evaluated pre-existing medical records, informed consent was not required. All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards.

This study included 310 patients who underwent THA procedures performed by the senior author (MU) between 2010 and 2017. These patients were divided into three groups. Patients who underwent hip resurfacing arthroplasty were included in group 1, those who underwent conventional-stem THA were included in group 2, and those who underwent short-stem THA were included in group 3. The Birmingham Hip Resurfacing System® (BHR, Smith & Nephew, London, United Kingdom) was used for all patients who underwent hip resurfacing, the Optimys TM® (Mathys, Bettlach, Switzerland) was used for all patients who underwent short-stem THA, and the Stryker Accolade® II (Stryker, Mahwah, NJ, USA) was used for all patients who underwent conventional-stem THA. All hip arthroplasties were performed using a posterolateral approach. The same reamerization method was used for the acetabular component in all patients. The inclusion criteria of the study consisted of the diagnoses of primary osteoarthritis and hip osteonecrosis. The radiographs were randomly chosen from two ongoing cohorts. The exclusion criteria consisted of previous hip surgery, previous trauma to the hip region, hip dysplasia, coxa vara, coxa valga, protrusio acetabuli, atients with BMI >30, those with diseases that may affect hip offset such as Perthes disease, and those undergoing total hip arthroplasty other than a posterolateral approach. According to these inclusion and exclusion criteria, 249 hips of 220 patients were included in the study. Radiographic measurements were performed via pelvic radiographs taken preoperatively and on the first postoperative day. These pre-op and post-op anteroposterior pelvic radiographs were obtained with the patient in the supine position with the lower extremity in 15° internal rotation and the patella in the frontal plane. Suboptimal pelvic AP x-Rays that did not meet the following criteria in pre-operative and post-operative x-Rays were excluded from the study:

- Obturator foramina and acetabular teardrops appear symmetrical and midsacral line aligns with the pubic symphysis
- Greater trochanters of the proximal femur are in profile and the lesser trochanters are partially superimposed over the femoral neck
- Sacrococcygeal joint 1-3 cm superior to the upper surface of the pubic symphysis

The patients were evaluated based on these anteroposterior pelvic radiographs taken preoperatively and on the first postoperative day. Femoral offset was calculated as the horizontal distance between the center of the femoral head rotation and the femoral shaft, and acetabular offset was calculated as the horizontal distance between the center of femoral head rotation and the midline of the pelvis. The sum of these 2 numerical values was recorded as femoroacetabular offset. These measurements were made based on the preoperative and postoperative radiographs for each patient. These measurement techniques are shown in **Figure 1**. The obtained measurements were individually recorded. Measurements were performed by two different orthopedists who were not part of the surgical team and were blinded to each other's measurements. The mean values of these two different measurements were used for statistical analysis.

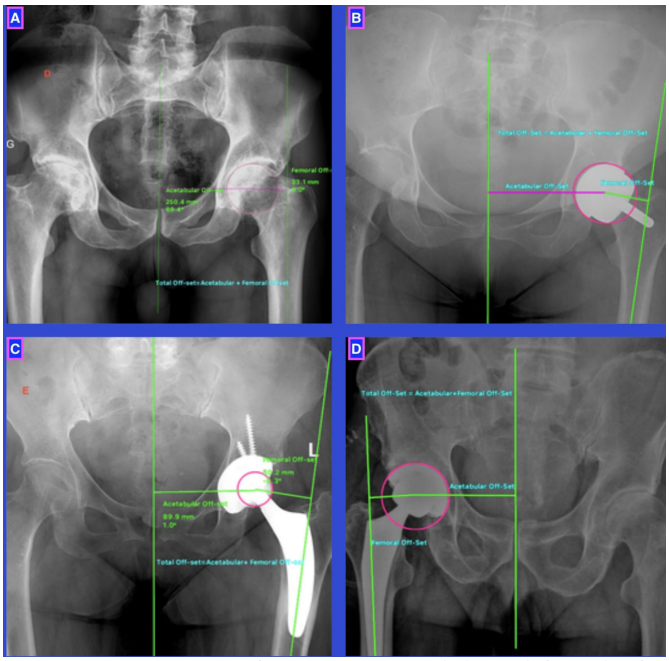

Figure 1. Demonstration of pre-operative acetabular and femoral offset measurement technique (A). Demonstration of post-operative acetabular and femoral offset measurement technique for hip resurfacing group (B). Demonstration of post-operative acetabular and femoral offset measurement technique for short femoral stem group (C). Demonstration of post-operative acetabular and femoral offset measurement technique for conventional femoral stem group (D)

Statistical Analysis

The data analysis was performed using the statistical package SPSS software (Version 25.0, SPSS Inc., Chicago, IL, USA). If continuous variables were normal, they were described as the mean±standard deviation [p>0.05 in Kolmogorov-Smirnov

test or Shapira-Wilk (n<30)], and if the continuous variables were not normal, they were described as the median. Comparisons between groups were applied using student T test or one way ANOVA for normally distributed data. The categorical variables between the groups were analyzed by using the chi-square test or Fisher Exc test. Pre-post measures data were analysed paired T test and repeated measure analysis. Values of p<0.05 were considered statistically.

RESULTS

In total, 249 hips of 220 patients were included in this study. Of these patients, 70 underwent hip resurfacing arthroplasty (group 1), 84 underwent conventional-stem THA (group 2), and 95 underwent short-stem THA (group 3).

The pre-op and post-op acetabular, femoral, and total offset values of all three groups are presented in Table.

When the offset measurement results of the groups were compared, it was found that there were statistically significant differences between the results of the groups except for the pre-op acetabular measurement results. As a result of post hoc analysis, it was determined that the statistical difference between the groups was due to the short-stem THA group (group 3). The measurement results of the short-stem THA group were significantly higher than those of the other groups.

When the changes of the results within the groups over time were analyzed, it was found that there were statistically significant differences between the pre-op and post-op results of group 1. There were statistically significant differences between all pre-op and post-op results of group 2 except for femoral offset measurements. There were also statistically significant differences between all pre-op and post-op results of group 3 except for total offset measurements.

When the differences between groups in the changes in the pre-op and post-op offset values were examined,it was found that there were only differences between the femoral measurement results and that the increase of the offset values in group 2 was statistically significantly smaller than that of the other groups.

Pre-op and post-op acetabular offset changes, femoral offset changes, and total offset changes of all three groups are shown in Figure 2, Figure 3, and Figure 4, respectively.

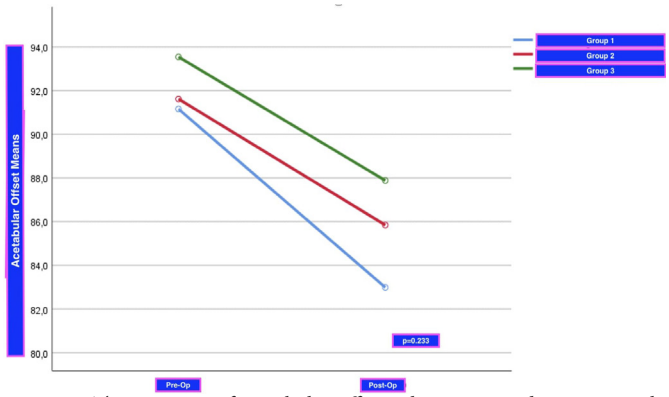

Figure 2. The variation of acetabular offset values measured preoperatively and postoperatively is shown

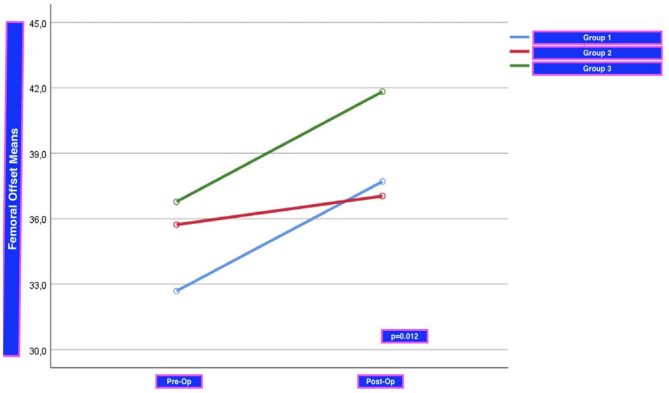

Figure 3. The variation of femoral offset values measured preoperatively and postoperatively is shown

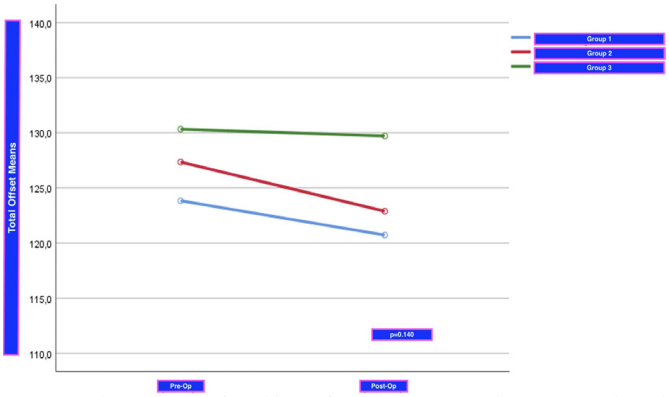

Figure 4. The variation of total hip offset values measured preoperatively and postoperatively is shown

Table. Preoperative and postoperative acetabular, femoral and femoroacetabular offset values of the groups and data on their statistical analyses

	Group 1, hip resurfacing arthroplasty (n=70)		Group 2, conventional-stem THA (n=84)		Group 3, short-stem THA (n=95)		p values
	Mean±SD	Min-max	Mean±SD	Min-max	Mean±SD	Min-max	p
Pre-op acetabular offset	91.2±7.1	74-109	91.6±13.3	59-133	93.5±11.2	65-123	0.324
Post-op acetabular offset	82.9±7.0	64-95	85.8±11.5	55-135	87.9±8.3	65-114	0.004
p*	0.0001		0.0001		0.0001		
Pre-op femoral offset	32.7±7.5	17-50	35.7±9.7	8.7-63	36.8±8.9	21-60	0.012
Post-op femoral offset	37.7±8.5	17-58	37.0±8.4	18-56	41.8±8.4	25-65	0.0001
p*	0.0001		0.211		0.0001		
Pre-op total offset	123.8±9.5	104-150	127.3±17.1	93-176	130.3±14.3	88-158	0.016
Post-op total offset	120.7±10.5	97-150	122.9±16.6	81-185	129.7±10.3	91-166	0.0001
p*	0.008		0.007		0.664		

All measurements in the table are in millimeters. p: One-way analysis of variance, p*: Dependent group T test, THA: Total hip arthroplasty, SD: Standard deviation, Min: Minimum, Max: Maximum

DISCUSSION

In THA, it is very important to restore the hip according to its natural anatomy since this has an impact on important parameters such as the risk of dislocation, range of motion, and wear.[17] Hip resurfacing arthroplasty, conventional-stem THA, and short-stem THA are common hip surgery procedures. The most important finding of this study is that short femoral stems are radiologically superior to conventional femoral stems and hip resurfacing in femoro-acetabular offset reconstruction.

The studies in the literature on acetabular offset reconstruction are limited in number.[18,19] In the acetabular preparation phase of THA, the acetabulum is resurfaced until the true acetabular floor is reached. Resurfacing of the acetabulum to the true acetabular floor reduces the lever arm of body weight during the monopedal stance, which reduces the compound force on the femoral head and thus improves the survival rate of THA.[20,21] For these reasons, all THA patients in this study underwent medialization for acetabular cup preparation. Similar to other studies, it was seen that this procedure reduced the acetabular offset in all groups in the postoperative period.[20,22] It is also known that the acetabular offset depends on the acetabular configuration, the surgeon's experience, and the technique used rather than the design of the cup.[23]

Different stem designs have been developed and used over the years to ensure that the implant maintains optimal bone integrity, exhibits adequate tribological properties, provides minimal bone resorption, and preserves hip geometry.[24] Short femoral stems have satisfactory short- and medium-term clinical outcomes.[25] Although conventional femoral stems also have satisfactory survival times, they are less successful than short stems, especially in femoral offset reconstruction.[14,26] Waard et al.[12] also compared short femoral stems with conventional stems using a templating program on femoroacetabular offset restoration in total hip arthroplasty and found that short femoral stems are potentially better at restoring femoroacetabular offset than conventional stems if the preoperative offset is ≥80.0 mm. There are no studies in the literature on the ability of hip resurfacing arthroplasty to reconstruct the femoral offset. In our study, the postoperative femoral offset values of both the resurfacing arthroplasty group and the short-stem THA group were statistically significantly higher than the preoperative values. However, no statistical difference was found between the preoperative and postoperative femoral offset values of the conventional-stem THA group. It was also found that the short-stem THA group had statistically significantly higher femoral offset increase compared to the other groups. In their study evaluating the results of procedures using two different short stems and conventional stems, Maurer-Ertl et al.[27] showed that hip geometry reconstruction could be achieved more easily with short stems. Increasing the femoral offset ensures less joint reaction force, slows polyethylene wear, reduces the risk of dislocation, and allows the patient to have a healthier gait pattern.[9,10,28] In their study, Sneijders et al.[14] emphasized that femoral offset reconstruction with short femoral stems was more successful than femoral offset reconstruction with conventional stems. Many recent studies in the literature have shown that short-stem THA can be used to adequately reconstruct hip geometry.[29-33] All of these studies emphasize that increasing the femoral offset will have positive effects on hip geometry reconstruction. However, there is no clear consensus on how much the femoral offset should be increased to achieve the best results. Although not identifying the extent to which the femoral offset should be increased, Bullen et al.[34] showed in their study that a decrease of more than 20 mm in femoral offset during THA will have a serious impact on clinical scores, necessitating the establishment of a cut-off value. The current study has shown that hip resurfacing arthroplasty has effects similar to those of short-stem THA, especially in reconstructing the femoral offset.

In order to compensate for the decrease in acetabular offset due to acetabular medialization, it is necessary to increase the femoral offset. Otherwise, a decrease in total offset will occur, causing negative effects on the hip joint. In the present study, it was observed that total offset decreased in all groups postoperatively. This shows that the femoral offsets of the patients were not increased enough to tolerate a decrease in acetabular offset. It was also observed that the total offset values of none of the patients were below the cut-off value reported by Bullen et al.[34] However, in another study, it was reported that a decrease of 5 mm in total offset was sufficient for the associated clinical adverse effects to occur.[17] Accordingly, digital templating should be used in preoperative preparations and the acetabular, femoral, and total offsets of patients should be calculated. Patient-specific implants should be selected according to the results of these calculations.

The importance of anatomical reconstruction of the hip offset has been emphasized quite clearly in the literature. Kelly et al.[35] showed that in addition to the negative biomechanical effects, decreased hip offset also has a negative effect on patient reported outcomes. Digital templating systems can be used successfully to minimize the biomechanical and clinical effects of not performing anatomical offset reconstruction.[36] There is information in the literature that BMI negatively affects offset reconstruction, so including demographic data in the analysis will allow for better evaluation of the data.[37]

Limitations

This study has some limitations. First of all, its retrospective design naturally creates a limitation. Apart from this, the demographic characteristics of the patients (age, height, weight, BMI, etc.) were not included in the study. The lack of reliability and validity studies for radiological measurements can be considered a limitation. However, the authors did not conduct this examination because this measurement method, which has been previously studied for reliability and validity, is accepted in the literature. Conducting reliability and validity analysis related to the measurements may help overcome the limitations in future studies. Another limitation of the study is that the measurements were made on 2D radiographs without computer support.

CONCLUSION

The current study has shown that the implant and surgical method used, and the experience of the surgeon can all impact the success of hip geometry reconstruction. Increasing the femoral offset in femoral offset reconstruction is both clinically and radiologically important and, in this study, it was easier to achieve this increase with hip resurfacing arthroplasty or short-stem THA. Clinical evaluation of radiological data obtained with larger comparative groups would reveal the advantages and disadvantages of these implant types more clearly.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee (Date: 19.12.2022, Decision No: EK-No. 1239/2019).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

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

Author Contributions

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

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Sarcopenia

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ABSTRACT

Sarcopenia is the progressive and involuntary loss of muscle mass and strength that occurs with elderly age. In 2010, the European Working Group on Sarcopenia in Older People (EWGSOP1) characterised the condition primarily by low muscle mass. The definition of sarcopenia that has been most widely adopted is that proposed by the EWGSOP1, which was updated in 2019 to become the EWGSOP2. Acute and chronic sarcopenia was included in the EWGSOP2 guideline for the first time. Although there is no consensus on the exact aetiology of sarcopenia, it is widely accepted that the condition is related to the natural ageing process. There are many chronic diseases associated with sarcopenia, including: cancer, chronic obstructive pulmonary disease, chronic heart failure, Parkinson, cognitive impairment, depression, chronic kidney disease, diabetes mellitus, human immunodeficiency virus (HIV), anorexia and osteoporosis. The assessment of sarcopenia includes a variety of methods and screening tools that are easily accessible and practical. The EWGSOP2 algorithm is delineated as "find-assess-confirm-severity," or F-A-C-S. A multidisciplinary approach is imperative for the early diagnosis and treatment of this condition. Given the multifactorial pathogenesis of sarcopenia, no definitive pharmacological therapy currently exists. Enhanced patient education and adherence to clinical recommendations are pivotal. The most effective strategies for combating sarcopenia involve a combination of nutritional support and resistance-aerobic exercise programs. Further research is needed to explore new pharmacological treatment approaches.

Keywords: Sarcopenia, EWGSOP, acute sarcopenia, chronic sarcopenia, muscle strength

INTRODUCTION

Sarcopenia is the progressive and involuntary loss of muscle mass and strength that occurs with elderly age. This condition has been linked to several adverse health outcomes, including disability and mortality.[1] Skeletal muscle mass loss has been observed to commence around the age of 35, with a rate of loss of 1-2% per year. After the age of 65, this rate typically increases to approximately 3% per year.[2] Sarcopenia is generally considered to be a geriatric syndrome; however, it can also manifest in individuals under the age of 60 years due to a number of factors, including obesity, diabetes mellitus (DM), cardiovascular diseases, renal and hepatobiliary diseases, cancer.[3-6]

DEFINITION

The definition of sarcopenia was first made by Rosenberg et al.[7] in 1989. In the 36 years under review, a range of research communities have proposed divergent definitions. In 2010, the European Working Group on Sarcopenia in Older People (EWGSOP1) characterised the condition primarily by low muscle mass.[8] This definition was inadequate to describe the decrease in muscle mass. Consequently, in 2011, the International Working Group on Sarcopenia (IWGS) advanced a revised definition, characterising sarcopenia as a condition of low muscle mass accompanied by slow gait speed.[9] In 2014, the Foundation for the National Institutes of Health (FNIH) defined sarcopenia as a condition characterised by low muscle mass and low grip strength (FNIH, 2014).[10]

The definition of sarcopenia that has been most widely adopted is that proposed by the EWGSOP, which was updated in 2019 to become the EWGSOP2.[11] Diagnosis of sarcopenia according to EWGSOP2 guidelines is shown in **Table 1**.

Table 1. Criteria for the diagnosis of sarcopenia

Diagnosis is based on documentation of criterion 1 plus (criterion 2 or criterion 3)
1. Low muscle mass
2. Low muscle strength
3. Low physical performance

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PATHOPHYSIOLOGY

Sarcopenia is characterised by a significant reduction in type II muscle fibres.[12] Mechanisms explaining the pathophysiology of sarcopenia;

Neurodegeneration

As people get older, there is a decrease in the number of alpha motor neurons in the spinal cord and a loss of peripheral nerve fibers. The subsequent insufficiency in muscle fiber activation secondary to this suggests that neurodegeneration is a major pathophysiological factor contributing to the loss of muscle mass.[13]

Decrease in Anabolic Hormones

It has been demonstrated that anabolic hormones such as human growth hormone (HGH), insulin-like growth factor-1 (IGF-1), and testosterone play a crucial role in muscle tissue development. In geriatric patients, a decline in these hormones has been observed with advancing age.[14]

Sarcopenic Obesity Associated with Insulin Resistance

As human survival has increased, the proportion of individuals with low muscle activity and high fat content has increased.[15] High body fat percentage increases the risk of insulin resistance. Insulin resistance has been shown to be inversely proportional to skeletal muscle mass.[16] Current guidelines from the European Society of Clinical Nutrition and Metabolism (ESPEN) and the European Association for the Study of Obesity (EASO) define the combination of sarcopenia and obesity as "sarcopenic obesity".[17] Research showing that sarcopenic obesity is a risk for cardiometabolic and physical function remains topical.[18,19]

High Cytokine Levels

Inflammatory cytokines such as tumor necrosis factor-alpha (TNF), C-reactive protein (CRP), interleukin (IL)-1 and IL-6 increase in chronic diseases and elderly. High levels of cytokines cause a decrease in protein synthesis in the muscle cell and a catabolic effect on skeletal muscle.[20]

STAGING AND CLASSIFICATION

Muscle strength and mass can change throughout a person's life. After age 50, there is an approximate 1-2% annual decline in leg muscle mass and a 1.5-5% annual decline in muscle strength. Staging and classification of sarcopenia are shown in Table 2 and 3.[8]

Table 2. Sarcopenia staging according to the European Working Group on Sarcopenia in Older People-2

Pre-sarcopenic stage	Muscle mass is decreased, while muscle strength and physical performance remain unaffected
Sarcopenic stage	Muscle mass is reduced, accompanied by a decline in either muscle strength or physical performance
Severe sarcopenia	All three criteria-muscle mass, muscle strength, and physical performance-are reduced

ACUTE AND CHRONIC SARCOPENIA

In EWGSOP2, new subgroups were updated as acute and chronic sarcopenia. Sarcopenia lasting less than 6 months is acute sarcopenia, if it lasts longer than 6 months, it is defined as chronic sarcopenia. Acute sarcopenia is usually an acute disease, whereas chronic sarcopenia is associated with chronic and progressive conditions and may increase the risk of death. This distinction was made to emphasise the importance of periodic control in patients at risk of sarcopenia. Acute sarcopenia is typically associated with an acute illness, while chronic sarcopenia is linked to ongoing and progressive conditions that may increase the risk of mortality. This distinction underscores the necessity for periodic evaluations in patients deemed to be at risk of sarcopenia.[11]

Table 3. Sarcopenia classification according to the European Working Group on Sarcopenia in Older People-2

Primary sarcopenia	
Age-related sarcopenia	No other cause evident except ageing
Secondary sarcopenia	
Activity-related sarcopenia	Physical inactivity, sedentary lifestyle
Disease-related sarcopenia	Advanced organ failure (cardiac, hepatic, renal etc.), inflammatory diseases, malignancies, endocrine disorders, osteoarthritis, and neurological disorders
Nutrition-related sarcopenia	Inadequate dietary protein and energy intake, as well as diseases and medications causing anorexia

ETIOLOGY

A study of adults aged 70 years and over reported the prevalence of sarcopenia to be 20.1% in men and 29.2% in women.[21] Another study, conducted in accordance with the 2019 diagnostic criteria of the Asian Working Group (AWGS), found the prevalence of sarcopenia among older adults to be 22.2% (24.1% in men, 21.3% in women).[22]

Although there is no consensus on the exact aetiology of sarcopenia, it is widely accepted that the condition is related to the natural ageing process.[23] A number of factors must be considered when investigating the issue of contributing factors in elderly. Such factors include reductions in type II muscle fibres, immobilisation and decreased physical activity, insulin resistance, obesity, an inadequate muscle protein synthesis response to resistance exercise, decreased serum concentrations of growth factors, and insufficient protein intake.[9,24]

There are many chronic diseases associated with sarcopenia, including; cancer, COPD, chronic heart failure, Parkinson, cognitive impairment, depression, chronic kidney disease, DM, HIV, anorexia and osteoporosis.[25-29] It is suggested that these diseases may affect muscle function in ways that limit physical activity or restrict calorie intake, leading to sarcopenia.[30]

A meta-analysis has shown that smoking increases the risk of sarcopenia.[27] Another systematic review found no evidence of a link between alcohol and the risk of sarcopenia.[31] Many studies have been conducted to determine the relationship between sleep duration and sarcopenia. However, the results of these studies are contradictory.[32] The relationship between sleep quality and sarcopenia needs further long-term research.

IDENTIFYING SARCOPENIA IN CLINICAL PRACTICE AND RESEARCH

The assessment of sarcopenia includes a variety of methods and screening tools that are easily accessible and practical. The EWGSOP2 algorithm is delineated as "find-assess-confirm-severity," or F-A-C-S (F-A-C-S; Figure).[11]

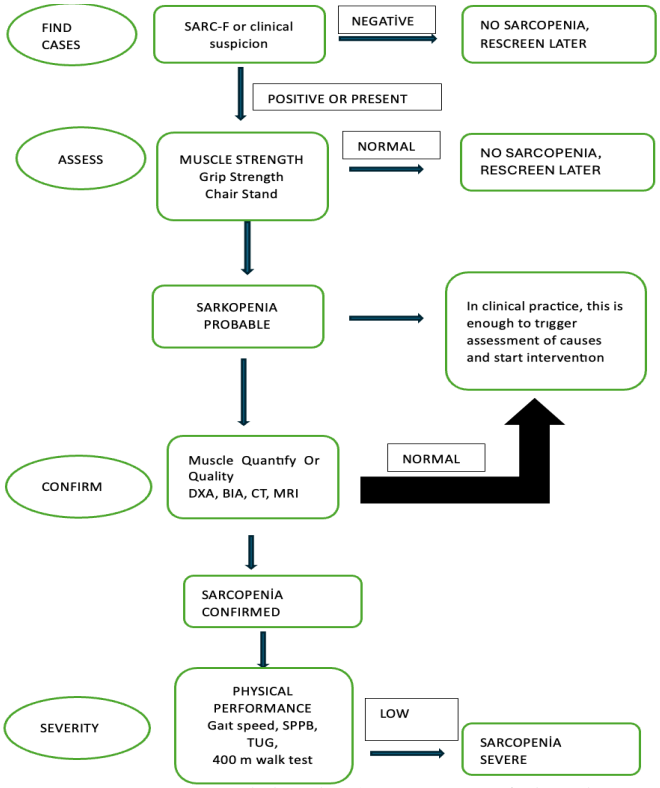

Figure. EWGSOP-2 practical algorithm (sarcopenia case finding, diagnosis and severity)

EWGSOP-2: European Working Group on Sarcopenia in Older People

SARC-F Questionnaire

The SARC-F questionnaire is a practical screening tool for sarcopenia that evaluates five categories: strength, walking, rising from a chair, stair climbing and experiences with falls.[33] The questionnaire shows low to moderate sensitivity but high specificity for predicting low muscle strength.[34] Each parameter is scored on a scale from 0 to 2, with a maximum total score of 10. A total SARC-F score of 4 or more indicates the need for further assessment of sarcopenia.[35] A project is underway to translate the SARC-F into multiple languages.[36]

MEASURING SARCOPENIA PARAMETERS

Muscle Strength

Handgrip Test: Grip strength has been shown to be an indirect measure of overall muscle strength, given its relationship to the strength of muscle groups in other parts of the body.[37] Reduced grip strength has been demonstrated to be associated with prolonged hospitalisation, diminished quality of life and functional impairment.[38] The Jamar dynamometer is a validated instrument for measuring grip strength. The recommended cutoffs for grip strength are <27 kg for males and <16 kg for females.[39]

Chair Stand Test: This practical test is used to assess quadriceps strength in the lower extremities. It measures how many times a patient can stand up and sit down from a chair without using their arms in 30 seconds.[40] The recommended threshold value for the chair stand test is five times for more than 15 seconds to stand up.[41]

Muscle Quantity or Quality

Numerous technical studies have been conducted to assess muscle mass. However, there is still no consensus on the most effective method for confirming sarcopenia. Each method has its strengths and weaknesses.[42]

Muscle quantity: The total body skeletal muscle mass (SMM), appendicular skeletal muscle mass (ASM), and the ratios of these masses to the associated height or body-mass index (BMI) value are calculated. Ratios such as (ASM/height^2), (ASM/weight), or (ASM/BMI) are then obtained.[43]

Magnetic resonance imaging (MRI) and computed tomography (CT): MRI and CT are non-invasive 'gold standard' methods for assessing muscle mass. However, due to their high cost, they are rarely used in routine practice. A definitive cut-off point for MRI and CT has not yet been established.[44]

Dual-energy X-Ray absorptiometry (DEXA): DEXA is a method that is frequently preferred by researchers and clinicians for the diagnosis of sarcopenia on account of the fact that it is both faster and more practical.[45] Adjustment is made for body size to calculate muscle mass (e.g., ASM/height^2, ASM/weight, ASM/BMI). However, there is no consensus on the most appropriate correction method or cut-off values.[46]

Bioelectrical impedance analysis: BIA is probably the most common method used to quantify SMM and ASM.[11] BIA employs a conversion equation that has been calibrated against the lean body mass measured by DEXA.[47]

Measuring Physical Performance

The physical performance tests used to determine the severity of sarcopenia recommended in the EWGSOP2 guideline are as follows:

Gait Speed Test: The 4-meter walk test, in which the time taken to complete the distance is measured using a hand-held stopwatch, is a practical assessment.[48] EWGSOP2 recommends the implementation of a single cutoff of ≤0.8 m/s as an indicator of severe sarcopenia.[11]

Short Physical Performance Battery (SPPB): The SPPB is a comprehensive evaluation test that encompasses chair-stand test, balance test, and gait speed. A total score of ≤8 has been shown to be indicative of poor physical performance and potentially more severe sarcopenia.[49]

Timed-up and Go (TUG) Test: The TUG test evaluates physical function. The patient getting up from the chair, walking 3 meters forward and 3 meters back again and sitting on the chair. The completion of this task within a time frame exceeding 20 seconds is indicative of a physical limitation.[50]

400-Meter Walk Test: Patients are instructed to complete 20 laps of a 20-metre track as expeditiously as possible, with up to two rest periods permitted. A total time exceeding six minutes is indicative of a potentially more severe degree of sarcopenia.[51]

Alternative Tests and Tools

Lumbar 3rd vertebra imaging by computed tomography: CT scans performed at the L3 vertebra level have been demonstrated to exhibit a strong correlation with total body muscle mass. This method is frequently employed, particularly in cancer patients, for early detection of sarcopenia.[52]

Ultrasonography: Ultrasonography is a rapid, practical, and reliable means of evaluating both muscle quantity and quality. The Sarcopenia Group of the European Geriatric Medicine Society (EuGMS) has proposed a consensus protocol for

the utilisation of ultrasound in muscle assessment.[53] The evaluation of muscles, such as the quadriceps femoris, has the capacity to provide information regarding muscle thickness and cross-sectional area in a relatively short timeframe.[54]

Creatine Dilution Test: The primary application of this technique is within the domain of clinical research. Following the administration of a loading dose of D3-creatine, the total body creatine pool and muscle mass can be calculated.[55]

Self-Administrated Quality of Life Questionnaire for Sarcopenia (SarQol): This is a self-administered questionnaire for individuals diagnosed with sarcopenia. Its purpose is twofold: firstly, it identifies complications that may arise from sarcopenia over time and secondly, it predicts the potential impact of these complications on the quality of life.[56]

TREATMENT

The management of sarcopenia is a multifactorial process that encompasses a combination of pharmacological and non-pharmacological approaches. Early diagnosis and treatment are important for preventing the progression of sarcopenia. A substantial body of research has demonstrated that the most efficacious treatment for sarcopenia is a combination of resistance and aerobic exercise, in conjunction with sufficient protein and energy intake.[57] Evidence has demonstrated that resistance training in sarcopenia can lead to a number of notable biological changes. These include an increase in muscle strength and mass, enhanced anabolic hormone production, a reduction in catabolic cytokine activity, and an improvement in bone density. Concurrently, the risk of fractures associated with osteoporosis can be reduced.[58] In geriatric patients, low-speed resistance exercises (2-3 seconds in the concentric phase followed by 2-3 seconds in the eccentric phase for each muscle) have been demonstrated to be the most effective way to improve muscle strength.[59] The impact of aerobic exercise on skeletal muscle has been a subject of considerable research interest, with numerous studies highlighting its beneficial effects on various physiological parameters. The exercise-induced increase in the number and function of mitochondria has been a notable finding, with research indicating that this contributes to reduced insulin resistance, enhanced exercise capacity, and a reduction in oxidative stress. A substantial body of research has demonstrated that aerobic exercise is the most efficacious approach for enhancing muscle strength and physical performance in sarcopenic individuals.[60] In order to achieve a significant clinical improvement in sarcopenia, it is essential that resistance and aerobic exercise programmes are continued for a minimum period of three months.[61]

The efficacy of exercise programmes in the treatment of sarcopenia should be enhanced through nutritional interventions. The impact of resistance exercise has been shown to be augmented by protein supplementation (1-1.2-1.6 g/kg/day, with 25-30 g of protein at each meal) taken after exercise, as well as improving muscle strength and function.[62] The efficacy of protein supplements rich in leucine (present in peanuts, soybeans, lentils, chickpeas, beef, fish, and chicken) or whey protein in increasing muscle mass is well-documented, although the effect on physical performance remains controversial.[63]

The ingestion of minimally processed natural foods (a diet in the style of the Mediterranean) once or twice per day has been demonstrated to be advantageous for muscle and bone health. The ingestion of natural dairy products has been demonstrated to reduce the risk of falls by 11% and fractures by 33%.[64] It has been demonstrated that the natural intake of calcium in excess of 1000 mg and protein levels ranging from 1.2 to 1.5 g/kg/day offers a protective effect against sarcopenia in older adults.[65]

Omega-3 polyunsaturated fatty acids (PUFA) supplementation has been found to increase lean body mass and skeletal muscle mass. Its long-term (beyond six months) use has been shown to be effective in the prevention of sarcopenia and the improvement of physical performance.[66] Evidence suggests that omega-3 supports and improves neuromuscular function, exerting a neuroprotective effect on the motor cortex with long-term supplementation.[67]

The administration of daily doses of 1-3 g of β-hydroxy-β-methylbutyrate (HMB) over a period of 8-24 weeks has been demonstrated to exert a positive influence on muscle strength and body composition. Nevertheless, the effect on muscle mass is comparatively negligible.[68]

Creatine supplementation (3-5 g/day) when combined with resistance exercise has been demonstrated to exert a positive effect on muscle and bone strength, bone and fat mass, and physical performance.[64] However, the efficacy of creatinine in the treatment of sarcopenia and chronic disease is controversial.[69]

Sarcopenia has a reduced gut flora. The administration of oral probiotic therapy, comprising *Lactobacillus roche* and *Lactobacillus galaei*, has been shown to reduce proinflammatory cytokines and potentially enhance muscle mass in cases of sarcopenia.[70]

The evidence suggests that a lack of vitamin D has a detrimental effect on muscle and bone health. The impact of vitamin D supplementation alone on sarcopenia has been demonstrated to be only mildly effective in enhancing muscle strength.[71] However, the combination of vitamin D supplementation with other nutritional interventions (e.g. leucine, probiotics, whey protein) and resistance exercise has been demonstrated to enhance muscle mass and improve physical performance in sarcopenia.[72]

Testosterone supplements have the potential to increase muscle strength in both men and women.[73] However, testosterone can cause complications such as prostate cancer, cardiovascular diseases and polycythemia vera.[74] Patient choice is important in testosterone treatment.

The influence of herbal supplements containing alkaloids, catechins, proanthocyanidins, gingerols, curcumin, and shogaols on skeletal muscle function appears to be minimal. Conversely, appetite-enhancing drugs such as ghrelin and megestrol acetate have been observed to potentially facilitate an increase in body weight and muscle mass.[75,76]

Myostatin, a hormone secreted by skeletal muscle, has been shown to inhibit muscle anabolism. Concurrent utilisation of myostatin inhibitors and resistance exercise regimens has been demonstrated to exert a positive influence on muscle mass.[77] It has been demonstrated that angiotensin-converting enzyme (ACE) inhibitors, β-blockers, and troponin activators can also result in advantageous outcomes with regard to muscle mass and handgrip strength.[78,79] It has been

demonstrated that Bimagrumab, a monoclonal antibody that targets the activin II receptor, has the capacity to increase fat-free muscle mass and muscle volume.[80]

CONCLUSION

Sarcopenia imposes a substantial financial burden on healthcare systems, resulting in diminished quality of life for patients. A multidisciplinary approach is imperative for the early diagnosis and treatment of this condition. Given the multifactorial pathogenesis of sarcopenia, no definitive pharmacological therapy currently exists. Enhanced patient education and adherence to clinical recommendations are pivotal. The most effective strategies for combating sarcopenia involve a combination of nutritional support and resistance-aerobic exercise programs. Further research is needed to explore new pharmacological treatment approaches.

ETHICAL DECLARATIONS

Referee Evaluation Process

Externally peer-reviewed.

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The authors have no conflicts of interest to declare.

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Author Contributions

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

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