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Evaluation of the clinical and functional outcome of short-term versus long-term cast-immobilization in conservatively treated distal radius fracture

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Abstract

Aim: We aim to observe the clinical outcomes of our patients with distal radius fractures treated conservatively with cast immobilization.

Materials and Methods: This is a retrospective observational study of 52 (13 males and 39 females) patients with distal end radius fractures who were treated with cast immobilization.We noticed there were three different groups of patients with different periods of cast immobilization and the onset of rehabilitation.The first group (n=18) was undergone 4 weeks of cast immobilization, the second group (n=17) underwent 5 weeks, whereas the third group of patients (n=17) completed 6 weeks of cast immobilization.Wrist and affected hand rehabilitation were started soon after the discontinuation of the cast.All patients were assessed using a visual analog scale (VAS) for pain,Beck Depression Inventory (BDI) for emotional status, and the Disabilities of the Arm,Shoulder,and Hand(DASH) Score for overall hand function.All patients have also been evaluated for pain-free grip strength, and joints Range of Motion (ROM).The assessments were done right after removing the cast(pre-rehabilitation) and after completing rehabilitation(post- rehabilitation).

Results: The VAS score,grip strength,BDI,and DASH scores showed significant differences among all groups before rehabilitation ($p<0.01$).The ROM and the grip strength were found to be insufficient,while the BDI and DASH scores were not significantly improved with long-term immobilization when compared to short-term immobilization.All scores showed a statistically significant difference in all groups after the 6th month ($p<0.01$).

Conclusion: Short-term immobilization is a more effective functional outcomes and safer treatment modality before and after rehabilitation compared to long-term immobilization in the conservative treatment of distal radius fractures.

Introduction

Distal radius fractures are common injuries, which account for over 15% of the fractures of all extremities [1]. Most authors suggested that the treatment of distal radius fractures should include immobilization of the forearm with a dorsal plaster cast with ulnar adduction and palmar flexion of the wrist [2, 3], preferably for a period of four to six weeks. The length of the immobilization period has been previously questioned in the literature. Some authors suggested that three weeks is long enough [4-6], whereas others claimed one week of immobilization is adequate [7]. On the other hand, some researchers have even suggested that nondisplaced distal radial fractures do not need plaster immobilization [8, 9]. The one-week immobilization method is obviously short and safe, and assists in an early return to functional status [7]. However, there is little knowledge about the best immobilization period for nondisplaced fractures of the distal radius, thus remaining a topic of controversy.

The traditional assessment of clinical outcomes after distal radius fractures has focused on radiological parameters and objective physical variables such as wrist range of motion (ROM) and pain-free grip strength [10, 11]. The Disabilities of the Arm, Shoulder, and Hand Outcome (DASH) questionnaire [12] is a widely used self-assessment tool for evaluating outcomes following distal radius fractures.

This study aims to assess the clinical controversy regard-

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ing the optimal duration of cast immobilization for non-operatively managed distal radius fractures.

Materials and Methods

A total of 52 patients (13 males, 39 females; mean age: 58.30±11.76 years) were included in the study. All patients had AO 23-A-3 type of distal radius fracture and were treated conservatively by cast immobilization. All patients underwent a manual closed reduction in the emergency room using a local hematoma block (with 5 ml of prilocaine hydrochloride 2%) before manipulation. The position of immobilization depended on the direction of fracture displacement and reduction. The standard short arm cast was applied for all patients. Radiographs of the patients were taken following reduction, and the reduction was acceptable. Follow-up radiographs were taken on the 10^{th} day, 21^{st} day, 6^{th} week, and 12^{th} week.

Following radiological assessment, fractures exhibiting radial length loss exceeding 3 mm, dorsal angulation surpassing 10°, volar angulation exceeding 20°, or an intraarticular step-off greater than 2 mm were deemed to have unacceptable post-reduction alignment [13]. Adequate lateral radiographs were defined as those exhibiting a minimum of 50% overlap of the distal radius on the distal ulna. Fracture stability was assessed using Lafontaine's criteria, which encompassed dorsal angulation >20°, dorsal comminution, articular involvement, associated ulnar fracture, and age >60 years on pre-treatment radiographs. Fractures meeting three or more of these criteria were classified as unstable [14].

The demographic data such as age, gender, marital status, occupation and educational status of the patients were documented. The dominant hand of the patients was recorded. Most of the fractures occurred after minor trauma. Dual-energy x-ray absorptiometry (DEXA) was used to investigate whether fractures were associated with osteoporosis.

Cast duration was determined according to the clinical and functional status of the patient, preferably for a period of four to six weeks [2,3], therefore we group them into three groups. The patients in Group 1 (n=18) were undergone rehabilitation at the 4^{th} week, Group 2 (n=17) were undergone rehabilitation at the 5^{th} week, and Group 3 (n=17) were undergone rehabilitation at the 6^{th} week. Three groups of patients with different period of immobilization and different time of starting their rehabilitation was noted. Their clinical outcomes were measured pre-rehabilitation, post-rehabilitation and at 6^{th} month after discontinuation of the cast. Fracture unions were evaluated using standard wrist radiographs.

During the follow-up period, three patients had lost acceptable reduction and had to undergo surgery. The study included fractures meeting stability criteria, defined as radial shortening <3 mm, dorsal inclination <10°, and articular step <2 mm. Exclusion criteria comprised open fractures beyond the 7^{th} week of immobilization, osteoporotic fractures, unstable patterns such as volar Barton's fractures, immature skeletons (under 18 years old), bilateral fractures, fractures associated with tendon or neurovascular lesions, associated carpal fractures, marginal fractures, fractures resulting from a shearing mechanism, fractures with palmar deviation, irreducible fractures, fractures lacking initial adequate closed reduction, fractures on which closed reduction was not attempted, and patients with insufficient radiographic follow-up.

The study protocol adhered to the principles outlined in the Declaration of Helsinki and received approval from the local ethical committee of our hospital (Batman Training and Research Hospital Scientific Research Ethics Committee, Decision no: 264, Date: February 24, 2021).

Measurement parameters

Pain assessment

Pain severity was assessed using a 10-cm Visual Analog Scale (VAS) [15], with 0 indicating no pain and 10 indicating the most severe pain. Patients were instructed to indicate their pain levels at rest and during movement separately on the scale.

Pain-free grip strength

Pain-free grip strength (PFGS) was defined as the maximum grip force generated during an isometric contraction before experiencing pain [16]. In this study, all patients with distal radius fractures underwent evaluation using a hand dynamometer (Jamar; Sammons Preston, Inc., Bolingbrook, IL, USA). During the assessment, patients were seated on a chair with feet flat on the floor, while measurements were taken with the shoulder adducted, elbow flexed at 90°, and forearm in a neutral position between supination and pronation. Initially, patients were instructed on dynamometer usage. Subsequently, the researcher assisted in supporting the weight of the dynamometer without restricting its movement. During the PFGS test, patients were instructed to gradually increase grip force until pain onset and maintain this force for approximately 3 seconds. Grip strength was measured in kilograms-force. The PFGS was assessed three times with 1-minute intervals, and the average of these measurements was calculated.

Functional assessment

The Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire is frequently employed to assess the effectiveness of various treatment approaches in addressing and alleviating disability among individuals with upper limb disorders [17].

Mood assessment (Beck Depression Inventory)

The mood assessment tool, developed by Beck et al., aims to assess patients' depression status by capturing emotional, physical, cognitive, and motivational symptoms commonly associated with depression [18]. Comprising 21 questions, the scale prompts patients to select the expression that best describes their feelings from four options, each ranked from a steady state (0 points) to the worst-case scenario (3 points), resulting in a maximum score of 63. Scores ranging from 0 to 13 indicate no depression, 14 to 24 points denote moderate depression, and scores exceeding 25 points indicate severe depression. All evaluation parameters in the study were conducted before rehabilitation, post-rehabilitation, and at the 6-month follow-up.

Range of Motion (ROM)

Active range of motion is less extensive than passive range of motion [19]. Instruments utilized for measuring joint range of motion include the goniometer and the inclinometer. Both devices employ a fixed arm, protractor, fulcrum, and movement arm to determine the angle from the joint axis [20].

Rehabilitation

Rehabilitation program was organized as soon as after the plaster cast was removed. All patients were included in an isotonic and isometric wrist, finger, and elbow exercises program accompanied by a physiotherapist for five days a week, for a total of four weeks. Furthermore, transcutaneous electrical nerve stimulation (TENS) was administered in the conventional mode for 20 minutes preceding the exercise regimen, totaling 20 sessions. TENS therapy entails the use of low-voltage electrical current to alleviate pain. A TENS unit comprises a battery-operated device that delivers electrical impulses via electrodes positioned on the skin's surface. These electrodes are placed directly over the nerves associated with the pain or at trigger points [21].

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 21.0 software for Windows (IBM Corp., Armonk, NY, USA). The normality assumption was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Descriptive statistics for variables are reported as mean ± standard deviation, Median(min-max) for continuous variables and frequencies n (%) for categorical variables. The analyses of the continuous variables included in the study were conducted using ANOVA, Friedman test, and Kruskal Wallis test, depending on the fulfillment of assumptions, variable type, and the number of groups to be compared. In cases where ANOVA revealed a significant difference among groups, the DUNCAN multiple comparison test was employed to identify the group(s) responsible for the significance. Mean values with no significant difference identified by the DUNCAN multiple comparison test were denoted with the same letter. Pairwise comparisons of groups showing significant differences according to the Kruskal-Wallis test were performed using the Mann-Whitney-U test, and evaluated with Bonferroni correction (0.05/group count). Pairwise comparisons of time points with significant differences detected by the Friedman test were conducted using the Wilcoxon Signed Rank Test. Analysis of categorical data was carried out using Fisher-Freeman-Halton Exact tests, taking into account the number of categories (RowsXColumns) and expected values. Relationships between variables were determined using Spearman Rho correlation analysis. Throughout the study, a p-value of <0.05 was considered statistically significant.The sample size of the study was determined through Priori power analysis. When calculating the sample size, an effect size of f=0.25, α=0.05, Power (1-β err prob=0.95), Number of groups=1, Number of measurements=3, and Nonsphericity correction ϵ=1 were taken into account. The necessary sample size was found to be 43 based on power analysis results. Considering the reliability of other tests to be conducted and the study outcome, a sample of 52 participants was included. The sample size of the study was calculated using G*Power 3.1.9.6 (Frans Faul, Universitat Kiel, Germany) program.

Results

The patients were followed up for 8.2±2.3 months on average. The average age of the patients was 58.30 ± 11.76. There was no statistically significant between the groups in terms of mean age ($p>0.05$). A great majority (75%) of the patients were housewives, while in 92.3% (n=48) the dominant hand was the right hand and the left hand was 7.7% (n = 4)($p>0.05$). Dual-energy x-ray absorptiometry (DEXA) was used to investigate whether fractures were associated with osteopenia. DEXA displayed L1-L4 T-scores of -1.2±0.7 in Group 1, -2.4±0.7 in Group 2, and -2.05±1.3 in Group 3, suggesting osteopenia in all patients($p<0.01$) (Table 1).

The VAS scores were significantly different among all groups ($p<0.01$). Before rehabilitation, Group 3 had the highest VAS score. No significant difference was observed between Group 2 and Group 3 in pre-rehabilitation, post-rehabilitation and the 6^{th} month measurements. Long-term immobilization returned significantly insufficient ROM (wrist flexion, extension, ulnar and radial deviation) outcomes ($p<0.01$). The grip strength was also weaker in the long-term immobilization compared to short-term immobilization. However, the grip strength improved after rehabilitation, showing a significant difference with pre-rehabilitation measurements. As for BDI, the parameters decreased in all groups after rehabilitation. Although the best improvement was in Group 1, the improvement was statistically significant among all subgroups. The best DASH scores were observed in Group 3. Again, the improvement after rehabilitation was statistically significant among all groups (Table 2).

The average VAS score was 6.33±2.79 before rehabilitation and 1.54±1.44 at the 6^{th} month, exhibiting a statistically significant improvement ($p<0.01$). Following rehabilitation, ROM (wrist flexion, extension, ulnar and radial deviation) significantly improved ($p<0.01$). The best outcomes in terms of flexion and ulnar deviation were achieved at the 6^{th} month (57.30°±15.21° and 18.53°±3.09°, respectively), showing a statistically significant difference among the groups ($p<0.01$). Beck Depression Inventory score improved rapidly after rehabilitation. The average BDI score was 37.86±22.38 before rehabilitation and 13.65±12.95 at the 6th month, exhibiting a statistically significant difference ($p<0.01$) (Table 3).

Discussion

Short-term cast immobilization demonstrates greater effectiveness in functional outcomes and offers a safer treatment approach for conservatively managed distal radius

Table 1. Demographic data of the patients.

	Total	Group 1	Group 2	Group 3	P*
Age (year), Mean ± SD Median(min-max)	58.30±11.76 61 (26.0-77.0)	57.66±12.45 62(29-73)	58.84±10.08 57(50-77)	58.52±12.62 63(26-73)	>0.05
Gender, n (%)					
Male	13 (25.0)	7(38.9)[a]	0(0.0)[b]	6(28.6)[a.b]	<0.05
Female	39 (75.0)	11(61.1)[a]	13(100.0)[b]	15(71.4)[a.b]	
Marital status, n (%)					
Single	4 (7.7)	2(11.1)[a]	0(0.0)[a]	2(9.5)[a]	>0.05
Married	48 (92.3)	16(88.9)[a]	13(100.0)[a]	19(90.5)[a]	
Education status, n (%)					
Can't read or write	25 (48.1)	6(33.3)[a]	8(61.5)[a]	11(52.4)[a]	>0.05
Primary school graduate	20 (38.5)	7(38.9)[a]	5(38.5)[a]	8(38.1)[a]	
Graduated from a University	7 (13.5)	5(27.8)[a]	0(0.0)[a]	2(9.5)[a]	
Profession, n (%)					
Housewife	39 (75.0)	11(61.1)[a]	13(100.0)[a]	15(71.4)[a.b]	>0.05
Farmer	4 (7.7)	2(11.1)[a]	0(0.0)[b]	2(9.5)[a]	
Worker	4 (7.7)	2(11.1)[a]	0(0.0)[b]	2(9.5)[a]	
Officer	5 (9.6)	3(16.7)[a]	0(0.0)[b]	2(9.5)[a]	
DEXA(L1-L4 T-scores), Mean ± SD	-1.85±1.11 1	-1.22±0.71[a]	-2.40±0.74[b]	-2.05±1.34[b]	<0.0
Dominant Hand, n (%)					
Right	48 (92.3)	18(100.0)[a]	13(100.0)[a]	17(81.0)[a]	>0.05
Left	4 (7.7)	0(0.0)[a]	0(0.0)[a]	4(19.0)[a]	

*There is no significance between the groups shown with the same letter in the same row or column (P>0.05) DEXA:Dual-Energy Xray Absorptiometry, L:Lomber.

fractures. van Delft et al. [22] conducted a systematic review of 12 studies with 1063 patients. The study concluded that a period of immobilization lasting three weeks or less is non-inferior. Additionally, they suggested that such a duration of immobilization may be associated with better functional outcomes. They claimed that shortening the immobilization time in distal radius fractures should be considered. The result is consistent with our study finding that short-term immobilization was associated with better functional outcomes.

Bentohami et al. [23] concluded that shorter periods of immobilization were preferable for adult patients with conservatively managed distal radial fractures, based on observations of improved functional outcomes, reduced pain scores, lower incidence of nonunion, and fewer complications.

Based on our literature review, we found two randomized controlled trials comparing three weeks and five weeks of immobilization in a total of 133 patients [5, 6]. In the first one, Christensen et al. [5] concluded that three and five weeks of plaster immobilization produce equally good results in minimally displaced distal radial fractures. In both studies, no significant difference was observed in terms of anatomical or functional outcomes after nine months [9] and after one year of follow-up [6]. In our study, we observed no significant differences in terms of anatomical outcomes between the 4th week and 6th week results. However, in terms of functional outcomes, short-term immobilization seemed more advantageous regarding VAS, ROM, Beck Depression Inventory, and qDASH scores compared to long-term immobilization. The method for measuring hand grip strength has been detailed in the Methods section. It's noteworthy that the strength was expressed as a relative value (%), relative to the normative values established by Mathiowetz et al. [24], and measured similarly to the approach outlined in Bohannon et al.'s research [25]. The standards they followed take gender, age, and dominant side into consideration. In our study, we measured the hand grip strength following the same standards and observed that there was a significant improvement in patients who were applied short-term immobilization.

Boersma et al. [26] conducted a study comparing one week versus 4 to 5 weeks of cast immobilization for non-reduced distal radius fractures. They discovered that one week of plaster cast treatment for non-reduced distal radius fractures is feasible and preferred by patients. Additionally, they found that this approach resulted in at least equivalent functional and pain scores compared to treatment with 4 to 5 weeks of plaster cast immobilization.

Our study had few limitations. Our follow-up period of 6 months was relatively a short one, the other limitation is the lack of a control group. On the other hand, the fact that the same researcher followed up all the patients, and the application of the same rehabilitation program by the

Table 2. Pre- and post-rehabilitation measurements and inter- and intragroup comparison.

	Pre-rehabilitation	Post-rehabilitation	6^{th}-month				
	Median (min-max)	Median (min-max)	Median (min-max)	P^2	$P^{Pre-Post}$	$P^{Pre-6th}$	$P^{Post-6th}$
VAS							
G1	7.5(1-9)	2(0-5)	0 (0-1)	<0.001	<0.001	<0.001	<0.001
G2	9 (5-10)	5(0-8)	3 (0-3)	<0.001	<0.001	<0.001	<0.01
G3	9 (6-10)	5(2-8)	3 (0-5)	<0.001	<0.001	<0.001	<0.001
P^1	<0.001	<0.001	<0.001				
P^{G1-G2}	<0.01	<0.001	<0.001				
P^{G1-G3}	<0.001	<0.001	<0.001				
P^{G2-G3}	>0.05	>0.05	>0.05				
Flexion							
G1	45(25-60)	70(45-80)	76(50-80)	<0.001	<0.001	<0.001	<0.001
G2	30(20-30)	40 (30-60)	46 (40-60)	<0.001	<0.001	<0.001	<0.01
G3	20(10-30)	30(15-60)	45(20-75)	<0.001	<0.001	<0.001	<0.001
P^1	<0.001	<0.001	<0.001				
P^{G1-G2}	<0.001	<0.001	<0.001				
P^{G1-G3}	<0.001	<0.001	<0.001				
P^{G2-G3}	<0.001	>0.05	>0.05				
Extension							
G1	40(10-45)	60(30-70)	60(45-70)	<0.001	<0.001	<0.001	>0.05
G2	20 (15-25)	30(25-50)	40(30-50)	<0.001	<0.001	<0.001	<0.01
G3	15(5-30)	30(10-60)	35(10-60)	<0.001	<0.001	<0.001	<0.01
P^1	<0.001	<0.001	<0.001				
P^{G1-G2}	<0.001	<0.001	<0.001				
P^{G1-G3}	<0.001	<0.001	<0.001				
P^{G2-G3}	>0.05	>0.05	>0.05				
U. Deviation							
G1	18(10-25)	26(15-30)	29(20-30)	<0.001	<0.001	<0.001	<0.01
G2	10 (5-13)	18 (10-21)	18 (14-23)	<0.001	<0.001	<0.001	>0.05
G3	10(3-16)	12 (5-22)	14(5-28)	<0.001	<0.001	<0.001	<0.01
P^1	<0.001	<0.001	<0.001				
P^{G1-G2}	<0.001	<0.001	<0.001				
P^{G1-G3}	<0.001	<0.001	<0.001				
P^{G2-G3}	>0.05	<0.05	>0.05				
R. Deviation							
G1	10(6-18)	20(10-23)	20(10-24)	<0.001	<0.001	<0.001	<0.01
G2	8(4-10)	12(6-16)	13(10-18)	<0.001	<0.001	<0.001	>0.05
G3	5(2-8)	7(3-16)	8(3-20)	<0.001	<0.001	<0.001	<0.05
P^1	<0.001	<0.001	<0.001				
P^{G1-G2}	<0.001	<0.001	<0.001				
P^{G1-G3}	<0.001	<0.001	<0.001				
P^{G2-G3}	>0.05	<0.05	<0.05				
JAMAR							
G1	10(2-20)	26 (10-60)	35(22-80)	<0.001	<0.001	<0.001	<0.001
G2	3 (0-5)	10 (3-20)	20(8-30)	<0.001	<0.001	<0.001	<0.001
G3	4(0-10)	8(3-40)	20(5-50)	<0.001	<0.001	<0.001	<0.001
P^1	<0.001	<0.001	<0.001				
P^{G1-G2}	<0.001	<0.001	<0.001				
P^{G1-G3}	<0.001	<0.001	<0.001				
P^{G2-G3}	>0.05	>0.05	>0.05				
Beck Depression Scale							
G1	18(3-60)	6(0-42)	3(0-36)	<0.001	<0.001	<0.001	<0.001
G2	54(6-62)	30(3-43)	18(3-46)	<0.001	<0.001	<0.001	<0.001
G3	60(9-63)	36(0-63)	18(0-45)	<0.001	<0.001	<0.001	<0.001
P^1	<0.001	<0.001	<0.001				
P^{G1-G2}	<0.001	<0.001	<0.001				

$P^{G1\text{-}G3}$	<0.001	<0.001	<0.001				
$P^{G2\text{-}G3}$	>0.05	>0.05	>0.05				
qDASH							
G1	45(36-90)	20(5-60)	10(6-30)	<0.001	<0.001	<0.001	<0.001
G2	85(45-95)	60(30-75)	30(10-45)	<0.001	<0.001	<0.001	<0.001
G3	90(26-100)	72(25-90)	48(15-75)	<0.001	<0.001	<0.001	<0.001
P^{1}	<0.001	<0.001	<0.001				
$P^{G1\text{-}G2}$	<0.001	<0.001	<0.001				
$P^{G1\text{-}G3}$	<0.001	<0.001	<0.001				
$P^{G2\text{-}G3}$	>0.05	>0.05	>0.05				

G1: Group 1 (4thw); G2: Group 2 (5thw);); G3: Group 3 (6thw); 1: Kruskal Wallis, 2: Friedman VAS: Visual Analog Scale, U: Ulnar, R: Radial, DASH: The Disabilities of the Arm, Shoulder and Hand.

Table 3. Variables measured before and after rehabilitation, and 6th-month.

Variables	Pre-rehabilitation	Post-rehabilitation	6th-month	
	Median (min-max)	Median (min-max)	Median (min-max)	P*
VAS	7(1-10)[a]	4.5 (0-8)[b]	2(0-5)[c]	<0.001
Flexion	30(10-60)[a]	50(15-80)[b]	50(20-80)[c]	<0.001
Extension	21(5-45)[a]	40(10-70)[b]	45(10-70)[c]	<0.001
U. Deviation	10(3-25)[a]	16(5-30)[b]	19(5-30)[c]	<0.001
R. Deviation	8(2-18)[a]	12(3-23)[b]	16(3-24)[c]	<0.001
JAMAR	5(0-20)[a]	16 (3-60)[b]	25(5-80)[c]	<0.001
Beck depression score	43 (3-63)[a]	27(0-63)[b]	10(0-46)[c]	<0.001
qDASH	85(26-100)[a]	45(5-90)[b]	23(6-75)[c]	<0.001

*: Differences between time points were tested using the Friedman test, and pairwise comparisons of time points were conducted using the Wilcoxon Signed Rank test. In the Wilcoxon Signed Rank test results, mean values with no statistically significant differences within the same row were denoted with the same letter (P>0.05). VAS:Visual Analog Scale, U: Ulnar,R: Radial,DASH: The Disabilities of the Arm, Shoulder and Hand.

same physical therapist may be considered a strength of our study.

Conclusion

In summary, the 3-week cast immobilization period has been found to be sufficient and more effective and functional compared to 6-week immobilization period for conservatively managed distal radius fractures. Additionally, it facilitates faster improvement in wrist function and enables an earlier return to work.

Conflict of interests

The authors declare no competing interests relevant to the content of this article.

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Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Ethical approval

Ethical approval was received for this study from Batman Training and Research Hospital Scientific Research Ethics Committee (Decision no: 264, Date: February 24, 2021).

Author contributions

Conception: Erdal Güngör (EG), Zeynep Karakuzu Güngör (ZKG); Design: EG, ZKG; Supervision: EG, ZKG; Fundings: EG, ZKG; Materials: EG, ZKG; Data collection and/or processing: EG, ZKG; Analysis and/or interpretation: EG, ZKG; Literature review: EG, ZKG; Writer: EG; Critical review: EG.

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