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Original Article

Effects of Powerball Exercises in Addition to Routine Physical Therapy on Pain, Grip Strength and Functional Disability in Patients with Carpal Tunnel Syndrome

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ABSTRACT

Background: Carpal tunnel syndrome is a common entrapment neuropathy that often presents with pain, numbness, tingling and weakness in the hand and arm. Delayed treatment may worsen the symptoms and progresses to permanent sensory loss and thenar paralysis in some cases. **Objective:** To determine the comparative effects of Powerball exercises and strength training on pain, functional disability and grip strength in patients having carpal tunnel syndrome. **Methods:** This controlled trial was done from March to December 2022 at Badar Medical Complex on 86 patients that were recruited through purposive sampling. group A received routine physical therapy only while group B received Powerball exercises and routine physical therapy. Participants of both gender with aged 45-60 years were clinically diagnosed syndrome with a time span of more than two months and numbness over the dorsum surface of the thumb, index, middle and lateral 1/3rd of ring fingers and positive Tinel's sign with Phalen's maneuver were included in the study. Pain, grip strength and functional status were the outcome measures, observed through a numeric pain rating scale, hand-held dynamometer and Boston carpal tunnel syndrome questionnaire at baseline, 2nd and 4th week. Independent t-test and mixed-design analysis of variance were used for between and within-group differences respectively. **Results:** The mean age of participants was 37.10 ± 7.85 and there were 50 (58%) females and 36 (42%) males in the study and 46 (54%) participants had normal body mass index, 44 (51%) had right-sided carpal tunnel syndrome. The results showed significant between-group differences in pain, and functional disability ($p<0.05$). However, no significant difference was observed for grip strength. The within-group difference was found significant in both groups for all variables ($p<0.05$). **Conclusion:** The addition of Powerball exercises with routine physical therapy is more effective in reducing pain and improving functional disability and grip strength in patients with carpal tunnel syndrome than physical therapy alone.

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INTRODUCTION

Carpal tunnel syndrome (CTS) is one of the most frequently diagnosed illnesses of the upper extremities, making up to 90% of all entrapment neuropathies.[1] According to clinical and electrophysiological testing, CTS is detected in one among five individuals who report symptoms of pain, numbness, and tingling in their hands. It is reported to primarily affect women with a mean age of diagnosis around 50 years.[2] Conceded treatment in CTS could wreck the secondary effects and advances to prevent the impact of injury and loss of movement in some cases.[3]

The median nerve is compressed at the wrist as it travels through a constrained osteofibrous canal, which is the source of the condition. Any factor increasing the pressure in the wrist such as edema, chronic inflammation, increased soft tissue thickness, hormonal changes, and manual activity, can compress the median nerve.[4,5] Suspected risk factors of carpal tunnel syndrome include diabetes mellitus, menopause, hypothyroidism, obesity, arthritis, and pregnancy. The incidental effects of CTS could vary across patients.

They frequently express one or more symptoms of weakness, discomfort, numbness, or paresthesia, particularly in the thumb, index, and middle fingers, which are made worse at night.[6] This can incite basic activity impairment, work-related handicaps and discomfort.[7] However, the severity may range into mild, moderate, and severe.[8] There are numerous treatment options available in conservative management and surgical release for CTS.[9] For mild to moderate symptoms, conservative treatment is the first choice that includes rest, splinting, non-steroidal anti-inflammatory medications, vitamin B, local corticosteroid injections and physical therapy.[10,11,12] The patient's duration of treatment is pertinent to the management strategy.[13] The Powerball exercises in the form of resistance training are considered useful in increasing grip strength among patients with CTS and the possible benefits of the regime as effective means of rehabilitation for hand and wrist injuries. The purpose of this study was to determine the use of exercises with a Powerball in deterrent planning to manage pain, functional disability and grip strength in patients with this syndrome.

METHODS

This was a randomized clinical trial conducted using the Consolidated Standard of Reporting Trials (CONSORT) guidelines as given in Figure I. It was registered in ClinicalTrial.gov with Id: NCT05460026. The Research Ethical Committee of the University of Lahore has approved conducting the research (Ref Id: REC-UOL-/82-03/2022). Informed consent was requested at the beginning of the trial from the participants. Confidentiality and anonymity of the data was ensured. All the objectives of the study were explained to the participants and was conducted in the Department of Physical Therapy, Badar Medical Complex, Lahore from March to December 2022.

The sample size was 86 participants (43 in each group) calculated using OpenEpi software using the mean of muscle strength, level of significant 95% and power of study 80%. The sample was selected by purposive sampling technique.[14] The participants of age between 45 to 60 years, both gender[15] of diagnosed with carpal tunnel syndrome[16] for more than two months, numbness over the dorsal surface of the thumb, index, middle, and lateral 1/3rd of ring fingers as well as positive Tinel's sign and Phalen's maneuver[17,18] were included in the study. Those presented with a history of any previous

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trauma, subluxation, dislocation, fracture, surgery or bony anomalies of the wrist during last 5 years, arthritis, cervical radiculopathy and use of corticosteroid injections were excluded from the study.[18, 19] After initial screening for eligibility and physical examination and by using computer-generated random numbers, the participants were divided randomly into two groups. The group A was given routine physical therapy which includes an ultrasound of frequency of 1MHz for 10 minutes, along with nerve gliding, strengthening exercises and tendon mobilization to the wrist with 10 repetitions of each per three sets.[23]

Group B was given Powerball exercises for five minutes with routine physical therapy.[24,25] The Powerball exercises with a visible counter display that shows the total revolutions accumulated during five minutes session with the Powerball exercises and records every hundred revolutions as one unit was used. The time duration of each session was 30 min, and there were three sessions on alternate days for four weeks. An independent assessor collected the data at baseline, 6th and 12th sessions. The pain was observed through a numeric pain rating scale (NPRS)[20], grip strength was measured using handheld dynamometry (HHD)[21] and functional disability was reported using Boston carpal tunnel syndrome questionnaire (BCTQ).[22]

The SPSS version-26 was used for data analysis and the quantitative variables were presented in the form of mean±SD. Qualitative data were expressed as frequencies and percentages. To determine the normality of data, the Kolmogorov-Smirnov test was used. Independent sample t-test was used for between-group difference and mixed design analysis of variance (ANOVA) was computed for the within-group difference at baseline, 2nd and 4th-week follow-up.

RESULTS

The mean age of participants was 37.1±7.85 and there were 50 (58%) females and 36 (42%) males in the study and 46 (54%) participants had normal BMI, 44 (51%) had right-sided carpal tunnel syndrome. Table I represented the group-wise comparison of demographic and outcome variables, where the p-value represented that the groups were equal at baseline. Independent sample t-test was applied for between-group comparison of mean score of pain, grip strength and functional disability.

There was a statistically significant change in pain and functiona scores in group B (p-value<0.005) than in group A. However, no significant difference was observed in grip strength in both groups as depicted in Table II. The mixed design ANOVA with Greenhouse-Geisser correction was used for within-group comparison of pain, grip strength and functional status, results given in Table III. The pain was significantly reduced in both groups at time points with F (1.35, 57.37) =226.23, p=0.000 and F (1.40, 59.01) = 591.5 of group A and group B respectively.

Moreover, post-hoc analysis using Bonferroni adjustment showed pain was reduced by a mean difference of 1.74 and 1.69 in group A and 3.00 and 2.51 in group B from baseline to 2nd week and 2nd to 4th week respectively. Grip Strength was also significantly improved at time points in both groups. The results of group A showed a significant within-group difference with F (1.48, 62.27) =236.11, p=0.000, post-hoc analysis depicted grip strength was improved from baseline to 2nd week was a mean of -4.95 and from 2nd week to 4th week was -4.74.

The results of group B were also significant with F (1.69, 71.18) =356.7, p=0.000, post-

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Figure I: CONSORT FLOW DIAGRAM

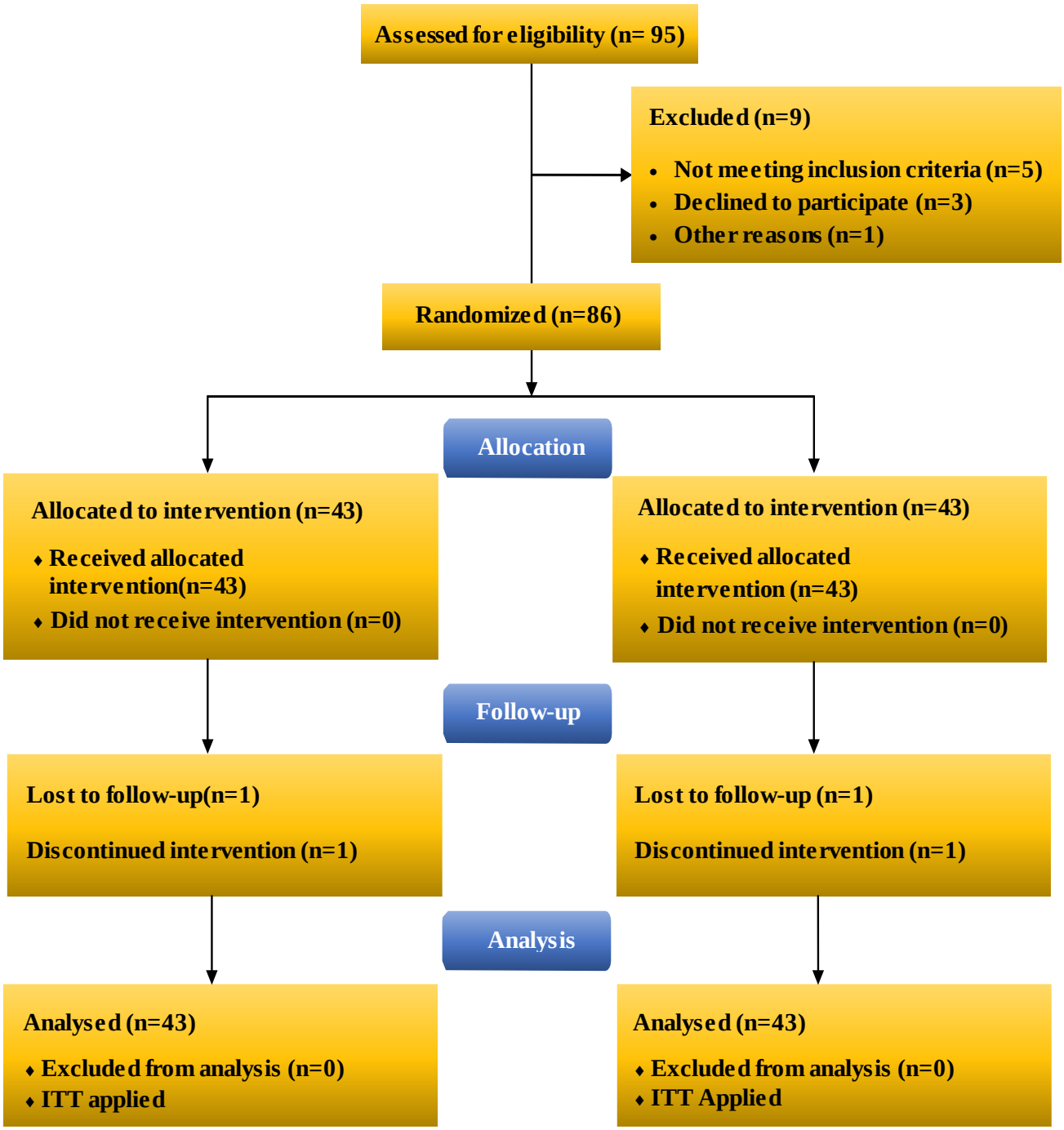

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Table I: Demographic Details and Outcome Variables of the Both Groups at Baseline

Variables	Characteristics	Routine Physical Therapy n (%)	Powerball Exercises & Routine Physical Therapy n (%)	p-value
Gender	Male	19 (22)	17 (19.8)	0.662*
	Female	24 (27.9)	26 (30.2)	
Affected Side	Right	21 (24.4)	23 (26.7)	0.66*
	Left	22 (25.6)	20 (23.3)	
Body Mass Index	Underweight	5 (5.8)	4 (4.7)	0.648*
	Normal	22 (25.6)	24 (27.9)	
	Overweight	11 (12.8)	13 (15.1)	
	Obese	5 (5.8)	2 (2.3)	
		Mean ± SD	Mean ± SD	
Age (Years)		38.58 ± 7.50	35.69 ± 7.99	0.08*
Pain (NPRS)		6.76 ± 1.55	7.16 ± 1.27	0.20*
Grip Strength (HHD)		24.34 ± 4.66	23.39 ± 5.35	0.38*
Functional Disability (BCTSQ)		39.16 ± 2.92	38.23 ± 1.49	0.06*

Table II: Between-group Comparison of Pain Intensity, Grip Strength and Functional Status

Treatment groups				
Outcome Variables	**Follow-up Session**	**Routine Physical Therapy (Group A) Mean ± SD**	**Powerball Exercises + Routine Physical Therapy (Group B) Mean ± SD**	**p-value**
Pain	At Baseline	6.76 ± 1.55	7.16 ± 1.27	0.20
	At 2nd Week	5.02 ± 1.55	4.16 ± 1.23	0.006*
	At 4th Week	3.32 ± 1.58	1.65 ± 1.44	0.000*
Grip Strength	At Baseline	24.34 ± 4.66	23.39 ± 5.35	0.38
	At 2nd Week	29.30 ± 4.27	29.37 ± 5.38	0.94
	At 4th Week	34.04 ± 4.65	34.06 ± 5.97	0.984
Functional status	At Baseline	39.16 ± 2.92	38.23 ± 1.49	0.06*
	At 2nd Week	35.62 ± 4.41	30.32 ± 1.10	0.000*
	At 4th Week	31.18 ± 5.99	22.90 ± 1.88	0.000*

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hoc analysis represented that grip strength was improved from baseline to 2nd week was a mean of -5.97 and from 2nd week to 4th week was -4.69. Functional disability was significantly reduced at time points in both groups. The results of group A showed a significant within-group difference with F (1.07, 45.25)=93.35, p=0.000, post-hoc analysis depicted function was improved from baseline to 2nd week was a mean of 3.53 and from 2nd week to 4th week was 4.44. The results of group B were also significant with F (1.15, 48.38) =2244.8, p=0.000, post-hoc analysis represented an improvement in function from baseline to 2nd week by mean of 7.9 and from 2nd week to 4th week was 7.41.

DISCUSSION

A survey coordinated by Jacques Herman Maree in the year 2015, entitled 'The effects of Powerball on dubious wrist torture'. The place of this study was to choose the effects of using the Powerball spinner as a treatment modality, concerning torture and change in diligence in the wrist for individuals with a wrist injury.[26] The audit involved 40 individuals that had an identical male-to-female scattering. Individuals should be between the set extents of 18 to 35 years of age to hinder any mistakes concerning the part's grip strength and are expected to meet the thought and aversions models preceding being recognized into the audit. The

Table III: Within-group Comparison of Pain Intensity, Grip Strength and Functional Status

Outcome Variable	Group	Time	Mean Difference	F	p-value	95% Confidence Interval for Difference	
						Upper Bound	Lower Bound
Pain	**Group A**	Baseline to 2nd Week	1.744	226.23	.000	1.354	2.134
		2nd to 4th Week	1.698		.000	1.428	1.967
	Group B	Baseline to 2nd Week	3.000	591.51	.000	2.668	3.332
		2nd to 4th Week	2.512		.000	2.186	2.837
Grip Strength	**Group A**	Baseline to 2nd Week	-4.95	236.11	.000	-6.176	-3.731
		2nd to 4th Week	-4.74		.000	-5.463	-4.025
	Group B	Baseline to 2nd Week	-5.97	356.7	.000	-7.008	-4.945
		2nd to 4th Week	-4.69		.000	-5.474	-3.921
Functional Disability	**Group A**	Baseline to 2nd Week	3.53	93.35	.000	2.417	4.652
		2nd to 4th Week	4.44		.000	3.421	5.463
	Group B	Baseline to 2nd Week	7.90	2244.8	.000	7.494	8.320
		2nd to 4th Week	7.41		.000	6.970	7.867

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individuals are expected to use the Powerball spinner for 5 minutes for each treatment meeting. The outcomes of this survey suggest that the Powerball whirligig determinedly influences the treatment and rebuilding of obscure wrist torture. The Powerball may be used as another choice, a moderate treatment technique or connected with an ongoing treatment show for treating sub-extraordinary or progressing obscure wrist torture. Besides the results showed that the power ball could go about as a grip-sustaining or constancy device to thwart future injury to the wrist.[27]

Another survey coordinated by Sehar Unver et al. in the year 2018 concluded the effects of hand practice performed with a Powerball on after effects and evaluated the results in participants having CTS. This study comprised of 19 participants (28 hands) that were dissected as CTS. For training treatment, a hand and finger practice ball that involves two segments: a foam body and versatile flexible ropes were used.

Participants put their fingers through each rope, squashed it for one second and a while later opened their fingers against the line for one second. Participants repeated this action for 30 seconds to one min per day. The results showed that recovery was performed from genuine evaluation results, hold strength and Boston overview scores. Around 21.4% of participants' electrophysiological results were negative close to the completion of the primary month and 32.1% of them were close to the completion of the third month. It is contemplated that Powerball practice is convincing in treating hold strength and extent of development in lenient encountering carpal section condition.

This study maintains the outcome of the present survey that a Powerball is fruitful in treating patients with carpal section conditions.[28] A survey conducted by Mionka H et al. in the year 2016 named carpal entry condition. Part I: reasonability of nonsurgical drugs a calculated study.' A best-confirmation mix was performed to summarize the results of the included assessments. Two reviews and 20 RCTs were integrated. Strong and moderate verification was found for the feasibility of ultrasound, evening propping, power ball, and the use of ergonomic control center differentiated and a standard control center, and standard estimating versus heat pads for a brief time. Similarly, moderate verification was found for ultrasound in the midterm.[29]

A survey done by Bionka M. in the year 2018 named carpal entry problem: sufficiency of treatment and electrotherapy modalities. An invigorated systematic overview of randomized controlled trials. A best-confirmation mix was performed to summarize the results of the included examinations (2 reviews and 22 randomized controlled starters). For practice-based recovery, moderate verification was found for myofascial rub treatment versus ischemic tension on inactive, or dynamic, trigger concentrations or low-level laser treatment until further notice. A strong verification is found against broadening and building up the workout. The finding of this study does not maintain the eventual outcomes of the current study.[18]

CONCLUSION

It was concluded that the addition of Powerball exercises in routine physical therapy is effective in reducing pain, and disability. However, grip strength was equally improved in both groups. The addition of Powerball exercises with routine physical therapy is more effective in reducing pain and improving grip strength and functional disability in patients with carpal tunnel syndrome than physical therapy alone.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods

were performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

Competing interests: None

Funding: No funding source is involved.

Authors' contributions: All authors read and approved the final manuscript.

CONSORT Guidelines: All methods were performed following the relevant guidelines and regulations.

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