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Effectiveness of theraputty exercises versus power web exercises on hand grip in patients with chronic type 2 diabetes mellitus: A comparative study

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Abstract
Objective: To compare the effectiveness of Theraputty exercises versus Power web exercises on hand grip in patients with chronic type 2 diabetes mellitus.
Subject and Method: 50 subjects having clinically diagnosed type 2 diabetes was taken. Subjects were divided into two groups – 25 each. Group A and group B were explained about the procedure. Group A received Theraputty exercises for 3 sets per day of 8-12 repetitions of each exercise with a rest of 3-5 min between each sets with frequency of 3 times a week for a duration of 6 weeks. Higher grade resistance were given after every 2 week starting with red which is of moderate resistance. Group B were given power web exercises for 3 sets per day of 8-12 repetitions of each exercise with rest of 3-5 min between each sets with frequency 3 times a week for a duration of 6 weeks. Higher grade resistance were given after every 2 week starting from red.
Result: In group A, the grip strength improved from 27±8.16 to 38.8±9.04. $p<0.0001$.In group B, the grip strength improved from 27.4±8.05 to 43.8±9.38, $p <0.0001$.When both the groups were compared, the p value was 0.0611 which is considered not significant.
Conclusion: Theraputty and Power web were individually proven to be effective in improving grip strength but when both the groups were compared, no significant difference was found in the improved grip strength.

Keywords: theraputty, power web, diabetes mellitus, grip strength, dynamometer.

1. Introduction

Diabetes mellitus

Diabetes mellitus is a metabolic disorder characterized by chronic hyperglycemia with resultant morbidity and mortality. According to International Diabetes Federation (IDF) prevalence of type 2 diabetes exceeds 250 million worldwide [1]. The prevalence of Diabetes mellitus in India ranges from 5–17%, with higher levels found in the southern part of the country and in urban areas [2]. The WHO estimated that there were 31.7 million persons with diabetes in India in 2000 and this number is likely to be 71.4 million in 2030. Clinical diagnosis of diabetes is made if a person has symptoms polyuria, polydipsia, polyphagia and casual plasma glucose concentration of more than 199 mg/dl or fasting plasma glucose level more than 125 mg/dl or two hour post glucose level of more than 199 mg/dl during an oral glucose tolerance test [3]. There are two main types of diabetes mellitus - Type 1 diabetes used to be known as juvenile onset diabetes or insulin dependent diabetes mellitus, but the disease can have an onset at any stage. It makes up around 5% -10% of all cases of diabetes. In type 1 diabetes, the pancreas is unable to produce any insulin, the hormone which controls blood sugar levels. In type 2 diabetes mellitus, also called as adult onset or non-insulin dependent, insulin secretion is inadequate because patients have developed resistance to insulin. Type 2 diabetes constitutes 90% of total diabetic population in world [4].

Musculoskeletal and neurological complications of chronic type 2 diabetes [5]

Conditions affecting hand
1) Diabetic cheiroarthropathy (stiff hand syndrome)
2) Trigger finger
3) Duputren's contracture

Conditions affecting shoulder
1) Frozen shoulder
2) Calcific periarthritis
3) Reflex sympathetic dystrophy

Conditions affecting feet: Diabetic osteoarthropathy (Charcot or neuropathic arthropathy)
Conditions affecting skeleton: Diffuse idiopathic skeletal hyperostosis

Conditions affecting nerves
1) Diabetic neuropathy
2) Carpal tunnel syndrome

Effect of chronic diabetes mellitus on grip strength

Muscle weakness has been associated with type 2 diabetes even among subjects with high BMI regardless of sex. Insulin resistance and hyperglycemia cause reduction in number of mitochondria in muscle cells, decrease in glycogen synthesis and increase in amount of circulating

systemic inflammatory cytokines, all of which have a detrimental effect on skeletal muscles [6]. Diabetes mellitus causes increased blood glucose in blood which results in damage to small blood vessels that supply blood to peripheral nerves. This results in damage to peripheral nerves and muscle weakness [7]. Also, subclinical neuropathic process involving motor neurons might be another possible underlying mechanism for poor muscle function in chronic diabetes [8]. A lower handgrip strength was consistently associated with a higher prevalence of type 2 diabetes mellitus in all ethnic groups, but handgrip strength did not explain ethnic difference in the prevalence of type 2 diabetes mellitus [9]. The hand muscles strength represented in grip strength is significantly affected by chronic type 2 diabetes mellitus. Such individuals have been found to have an augmented risk of developing functional disability due to hand muscles weakness which can lower productivity [10].

Theraputty

Theraputty can be used for a variety of hand exercises. This material is available in color-coded, graded levels of resistance. Theraputty exercises are commonly prescribed by physical and occupational therapists as part of a strengthening program [11]. Theraputty colour coded resistance grades [12].

Tan – extra extra soft
Yellow – extra soft
Red – soft
Green – medium
Blue – firm
Black – extra firm

Power web

The power web is an effective resistance exerciser for strengthening the muscles and joints of the fingers, hands and wrist. The resistance of each web can be modified to meet specific needs by adjusting hand position. Power web exercises help to maintain the dexterity in hands by increasing the range of motion in fingers and interphalangeal joints [13].

Table 1: Power web is available in colour coded resistance [14]

Level 0 (Beige) Beginners, stroke patients, persons with serious hand injuries, establishing range of motion.	Level 1 (Yellow) Children, geriatrics, beginning strength programs, arthritics, carpel tunnel.	Level 2 (Red) Most popular for all around use - such as strengthening, flexibility, injury rehabilitation, sports, fitness.	Level 3 (Green) advanced rehabilitation, sports , strengthening, fitness, injury prevention.	Level 4 (Blue) Sports strengthening for all major sports - for those that want to build real strength, very popular for pro sports training.	Level 5 (Black) A real challenge for advanced strengthening, used where hand strength is vital - such as karate, weight lifters, golf, baseball, football.

2. Materials and Methods

2.1 Selection of Subjects

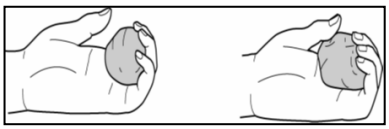
50 subjects clinically diagnosed with type 2 diabetes mellitus as mentioned in introduction with more than 6 years of history were taken in age between 45 to 69 years. Both males and females having right hand dominance were included. Subjects with sports person involving handgrip since 3 months, involved in occupation related to manual handling since 3 months, stroke patient involving hand function since 6 months, fracture to forearm or hand bones in recent 6 months, brachial plexus injury or peripheral nerve injury or carpal tunnel syndrome in recent 6 months, cervical spondylosis and radiculopathy. Subjects were divided in two equal groups of 25 each.

2.2 Outcome Measure

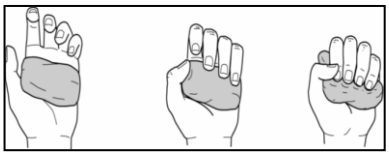
Grip Strength – (R=0.95, V=0.94). Hand grip strength can be quantified by measuring the amount of static force that the hand can squeeze around a dynamometer. A hydraulic hand held dynamometer is used to calculate grip strength. The dynamometer is placed in hand with subjects seated with shoulder in adduction, neutral rotation; elbow in 90˚ flexion; forearm in mid prone and wrist in 0-30˚ extension and 0-15˚of ulnar deviation. The dynamometer handle position is set at level II [10]. Instructions are given to squeeze the handle for 3-5 seconds with a rest of 15-20 seconds and three trials are taken [11]. The mean value measured in pounds.

2.3 Procedure

Group A received theraputty exercises for 3 sets per day 8-12 repetitions of each. exercise with a rest of 3-5 min between each sets with frequency of 3 times a week for a duration of 6 weeks. Higher grade resistance were given after every 2 weeks starting with red which is of moderate resistance



Finger hook



Full grip

Group B were given power web exercises for 3 sets per day of 8-12 repetitions of each exercise with rest of 3-5 min between each sets with frequency 3 times a week for a duration of 6 weeks. Higher grades were given after every two week starting with red.

3. Statistical Analysis

Statistical analysis within the group (intragroup analysis) was done using paired t test for the grip strength measured using hand held dynamometer. Intergroup analysis was done using unpaired t test to compare effectiveness between two groups.

4. Findings

4.1 Intragroup Analysis

Table 2: Intragroup analysis for hand grip strength after theraputty exercise using hand held dynamometer pre and post treatment scores (in pound) analyzed using paired t test.

Theraputty Exercises (Group A)	Pre treatment Value	Post treatment Value	T value	P value	Significance
	27 ±8.165	38.8 ±9.046	14.562	<0.01	Extremely significant

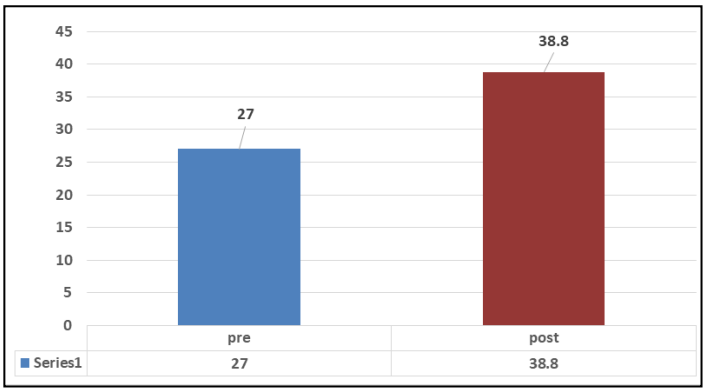


Fig 1: Pre and post Treatment scores after Theraputty exercises

Table 3: Intragroup analysis for hand grip strength after power web exercises using hand held dynamometer Pre and Post-treatment values (in pound) analyzed using paired t test.

Power web exercises (Group B)	Pre treatment value	Post treatment value	T value	P value	Significance
	27.4 ± 8.052	43.8 ± 9.385	13.201	<0.0001	Extremely significant

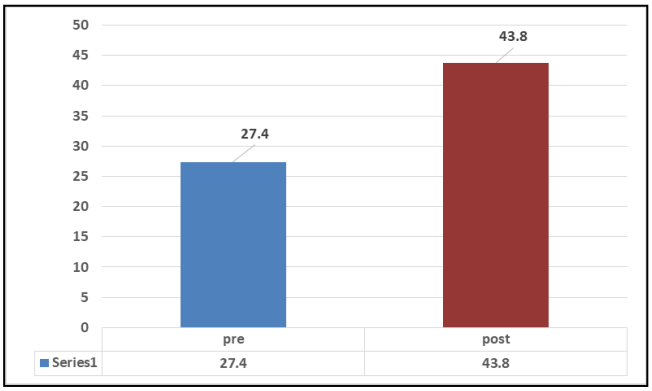


Fig 2: Pre and post treatment scores of power web exercises

4.2 Intergroup Analysis

	Post treatment score (Group A)	Post treatment score (Group B)
Mean ± sd	38.8 ± 9.046	43.8 ± 9.385
P value	0.0611 (Considered not significant)	
T value	1.918	

1. Intergroup analysis of hand grip strength post treatment values comparison using unpaired t – test

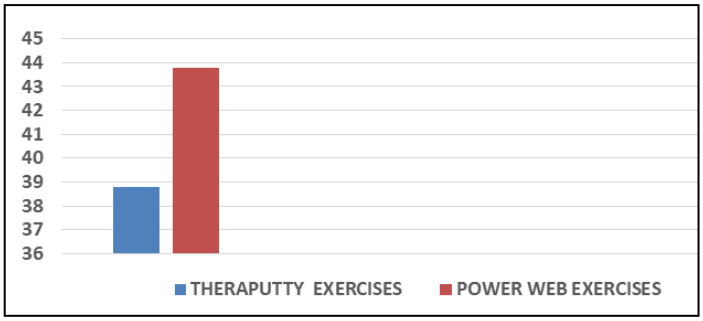


Fig 3: Intergroup grip strength (Group A vs Group B)

5. Result

In group A, the grip strength improved from 27±8.16 (Mean±SD) to 38.8±9.04 (Mean±SD). p<0.0001considered extremely significant. In group B, the grip strength improved from 27.4±8.05 (Mean±SD) to 43.8±9.38 (Mean±SD), p <0.0001.When both the groups were compared, the p value was 0.0611 which is considered not significant. Theraputty and Powerweb were individually proven to be effective in improving grip strength but when both the groups were compared, no significant difference was found in the improved grip strength.

6. Discussion

Type 2 diabetes mellitus is associated with upper limb muscle strength and quality. These features may contribute to upper limb functional limitation and disability in individuals with long standing type 2 diabetes mellitus**.** Significant reduction in muscle strength in diabetics compared to age matched healthy individual is explained by two mechanisms –increased insulin tissue resistance and hyperglycemia which cause reduction in number of mitochondria in muscle cells, a decrease in glycogen synthesis and increase in amount of circulating systemic inflammatory cytokines, all of which have detrimental effect on skeletal muscles. Another cause of muscle weakness could be underlying subclinical neurological process which involves motor neurons in long standing type 2 diabetes mellitus. P Sathya *et al*. have done a study in 2014 on power web and theraputty exercises to improve pinch strength in dental professionals. They found that power web had performed better than theraputty in improving grip strength measured by pinchometer. P Sathya *et al*. have done another study in 2016 on effect of resisted exercises (theraputty) vs. free weights for improvement in hand grip of cricket playes. They found that both resisted and free weight exercises were equally effective for improvement in hand grip in cricket players. Kavita R Wakpaijan *et al*. have done a study in 2017 on effect of pulley table exercises vs. theraputty exercises on hand grip in dentists and they found that both were equally effective in improving hand grip. In present study, we found that both theraputty and power web exercises were very effective in improving hand grip but there was no significant difference between theraputty and power web in improving hand grip in patients with chronic type 2 diabetes mellitus. There is direct correlation between tension producing capacity of muscle and physiological cross sectional area of individual muscle fibers. Hypertrophy is an increase in size of individual muscle fiber caused by an increase in myofibrillar volume. Hypertrophy of skeletal muscle fiber appears to be the result of increase in protein synthesis (protein and myosin) and decrease in protein degradation in muscle and increased uptake of amino acids. Studies have found that there may be possible hyperplasia of muscle fibers and hypertrophy of phasic type 2 muscle fibers. There is increase in motor unit recruitment, rate of firing and synchronization of firing. Resistance training increases ATP and phosphocreatine storage. It increases the numbers of myoglobin, creatine phosphokinase and myokinase. Also it increases strength of tendons and connective tissue in muscle [16].

7. Conclusion

The results of the study found that both theraputty and power web exercises are effective in improving hand grip in patients with chronic type 2 diabetes mellitus but there is no significant difference between theraputty and power web groups.

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