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A Comparative Study Between Eccentric Strengthening and Grip Strengthening for Forearm Weakness in Individuals of Dental Practices



Abstract: - Dental professionals require job-related physical demands that may lead to forearm weakness. This can make tasks involving gripping, lifting, and manipulating objects challenging. Hence, the study aims to investigate the impact of eccentric strengthening and grip strengthening for forearm weakness in individuals of dental practices. In the current study, 53 individuals met the inclusion criteria and provided their consent to participate. The individuals taking part in the study were assigned to two different groups, namely Group A and Group B, Group A(27) received the Eccentric exercise and Group B (26) received the Grip Strength exercise. The results of assessments for categories were assessed with an inch tape to measure the forearm circumference and 1 RM with the dumbbell. Two different sets of exercises were given to groups A and B for 5 days each week over a 4-week period. Individuals in dental practices with forearm weakness showed significant differences in the effectiveness of treatment between Group A and Group B. Both training methods were useful at increasing strength. The study results revealed a significant increase in the functional status of the forearm and optimum strength of grasp in the group A. During the dentists' training, eccentric strength therapy significantly increased their forearm strength.

Keywords: Eccentric strength, Grip strength, Forearm circumference, 1RM, Dentist.

I. INTRODUCTION

Dentist's hand function is essential to ensure safe and effective patient care. This encompasses strength for muscle movement, dexterity for precise actions, and eye-hand coordination when manipulating objects[1]. Dentistry is a profession that demands the practitioners of dental clinics to often maintain stationary positions, either standing or sitting, for extended durations, while keeping their posture in fixed positions for prolonged periods. Within the field of dentistry, inadequate ergonomics and repetitive tasks such teeth extraction, root canal can contribute towards premature fatigue. In recent years, multiple studies have reported a significant prevalence of musculoskeletal disorders within dental practitioners [2].

It is common knowledge that Dental professionals are at risk of developing forearm weakness due to the physical demands of their job that can cause strain on the forearm muscles due to their repetitive motions of wrist and awkward postures, such as holding the arm in an extended position for long periods, that can also contribute to forearm weakness[3]. In gripping activities, the muscles of the flexion in both the gripping surface of the hand and the forearm generate force for gripping, while the muscles of extensors in the forearm stabilize the joint at the wrist. These muscles rely on the palm of the hand to provide a stable surface for securely holding the gripped object[4].

Dentists rely on their hand function to effectively detect and remove calculus, polish teeth, and operate an ultrasonic scaler. They utilize a range of small instruments, including dental hygiene scalers, to carry out these tasks proficiently[5]. Dentists must possess expertise in manual dexterity and the use of highly precise tools. Tennis elbow and carpal tunnel syndrome are two common types of repetitive strain injuries in the upper extremities that can result from overuse of the arm which can cause elbow pain, especially when the arm is frequently bent and extended[6].

Human hand is famous for its complex structure and committed engine work of control and tangible capacities of transferring different profound and shallow sensations to the brain. The assessment of strength in the grip provides practical information of the work being performed. Hand grip strength has direct correlation with the forearm circumference[7].

Power grip serves as a key measure for evaluating impairment and tracking treatment progress in hand function. Analyzing strength of grip is crucial in hand rehabilitation programs as it evaluates the patient's initial limitations and

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allows comparison with typical levels. Continual assessment of hand grip strength is integral throughout the treatment process as it offers a rapid means of reevaluation. Considered by many as an objective indicator of upper extremity functionality, grip strength of hand can be enhanced through dependable evaluation methods [8].

Changes in forearm position have the potential to change the length of the hand's extrinsic muscle length. Extrinsic muscles are responsible for the majority of strength in the cylindrical power grip, fist grasp, and whole hand[9]. The power grip works muscles in the forearm that originate from the radius, ulna, and humerus, including digit flexors and extensors and the muscles of the thumb. These muscles pass across the wrist and finger joints, and some cross the elbow joint[10].

In recent times, there's been a significant focus on integrating eccentric exercise strengthening programs as a key element of strength training in recovery. Research indicates that isolated eccentric strength training has been proven effective for addressing, Achilles, patella and shoulder tendinopathy[11].

Hence the study is undertaken in an attempt to determine the effective treatment program for individuals with forearm weakness would have significant benefits for patient recovery and for the delivery of an improved service by healthcare providers.

II. METHODS & MATERIALS

2.1 Study design

The Ethical Committee and Protocol Committee authorized the research investigation (protocol number 074/2023-2024). The research is a cohort study involving 21-26-year-old participants including both genders from the Dental College at Krishna Vishwa Vidyapeeth, Karad, Maharashtra, India. This research recorded the pre and post-treatment values between the two groups and was conducted in the out patient department of Krishna College of Physiotherapy that lasted for a duration of 6 months.

2.2 Subjects

Participants were briefed on the study's nature, duration, and intervention in their language of choice. The inclusion criteria involved subjects currently working for 5-6 hours in dental practice with at least 2 years of clinical experience were included and also subjects with any upper limb pathological or neurological impairments and Participants who refused to take part in this study were not included. Subjects presenting at the Out-Patient Department (OPD) with forearm weakness reported experiencing diminished grip strength and compromised functional mobility as a result of the decreased forearm strength. They were assessed with an inch tape to evaluate the forearm circumference and 1 RM with a dumbbell.

The study evaluated an overall 90 individuals, out of which 53 individuals met the eligibility criteria and provided their consent to participate.

The individuals taking part in the research were assigned to two different groups, group A(27) received Eccentric exercise and group B(26) received Grip Strength exercise. During the 4-week program, two participants from Group A were unable to complete the protocol due to clinical engagements, resulting in their withdrawal and a member of Group B opted to resign from the protocol due to their personal choice of interest. (Fig no. 1)

2.3 Outcome Measure

A. Forearm Circumference

With the arm fully extended, three measurements of forearm girth were taken at the location where maximum muscle bulk was observed in the forearm. The circumference of the forearm was measured 2 cm distal to the cubital fossa.[12]

B. 1 RM

Maximal strength measurements, specifically the one repetition maximum (1RM), were gathered for the wrist utilizing a dumbbell during the assessment process.[13]

2.4 Treatment

Group A received Eccentric exercise- eccentric wrist extension, wrist radial deviation, forearm pronation and supination, and wrist extension with wand. Group B received Grip Exercise- GD grip exercise, softball exercise, towel exercise, rubber band exercise in individuals of dental practices. Groups A and B were assigned two distinct series of training. for 5 days each week over a 4-week period.(Fig no. 1)

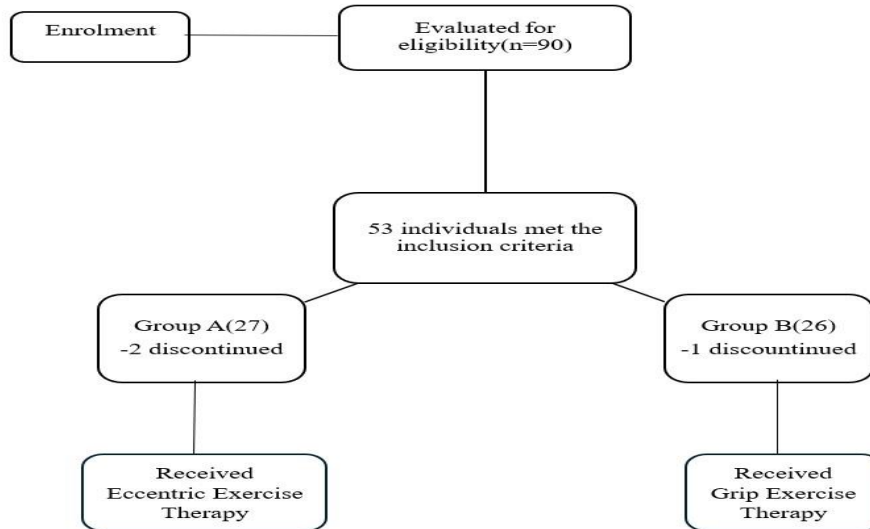


Figure no. 1

2.5 Data analysis

The data was entered into an Excel spreadsheet, and statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 26.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were utilized, and paired t-tests were employed to ascertain significant differences between pre- and post-training within groups, while unpaired t-tests were conducted to compare pre- and post-training values within the same group across all outcome measures.

Statistical significance was set at $p < 0.05$.

2.6 Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies has followed the tenets of the Declaration of Helsinki, and has been approved by the Institutional Ethics Committee of Krishna Vishwa Vidyapeeth (Protocol No.:074/2023-2024).

2.7 Informed consent

The informed consents had been obtained from all individuals who were involved in this research.

III. RESULTS

Table no. 1: Clinical Experience

No. of years	Group A Frequency	Group B Frequency
2 years	16	15
3 years	7	8
4 years	2	2

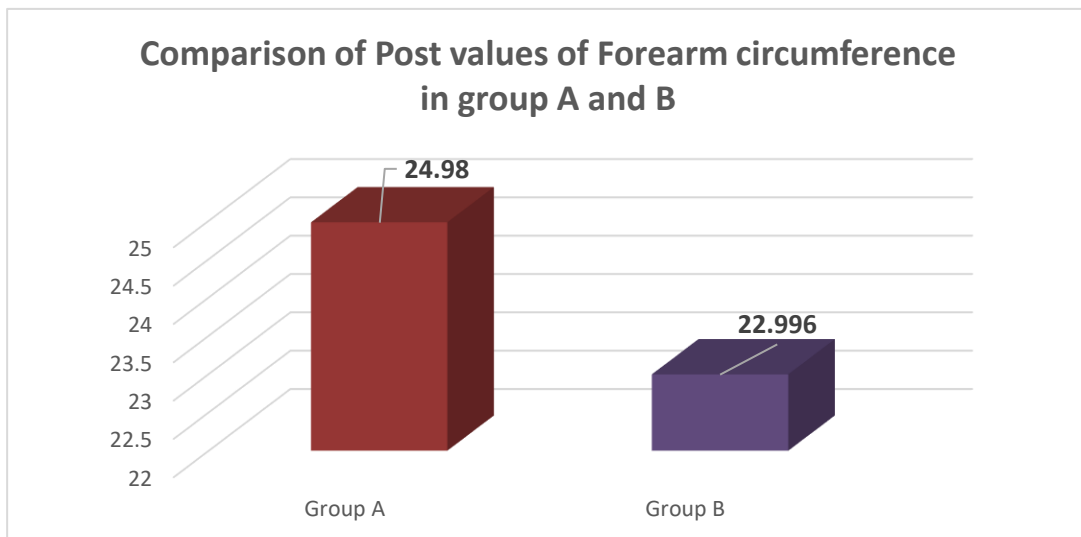
The clinical experience levels of individuals in Group A, it indicates that 64% had 2 years of experience, 28% had 3 years, and 8% had 4 years In Group B, 60% of individuals had 2 years of clinical experience, 32% had 3 years, and 8% had 4 years of clinical experience in dental practices (**Table no.1**).

Table no.2: Forearm circumference

Forearm Circumference			
Groups	Pre-Treatment	Post- Treatment	P- value
	Mean and SD	Mean and SD	
Group A	22.76±1.354	24.98±2.382	0.0002*
Group B	22.764±1.258	22.996±1.702	0.586#
P-Value	>0.9993#	0.001*	

*– extremely significant

#– not significant



Graph no.1: Comparison of Post values of Forearm circumference in group A and B

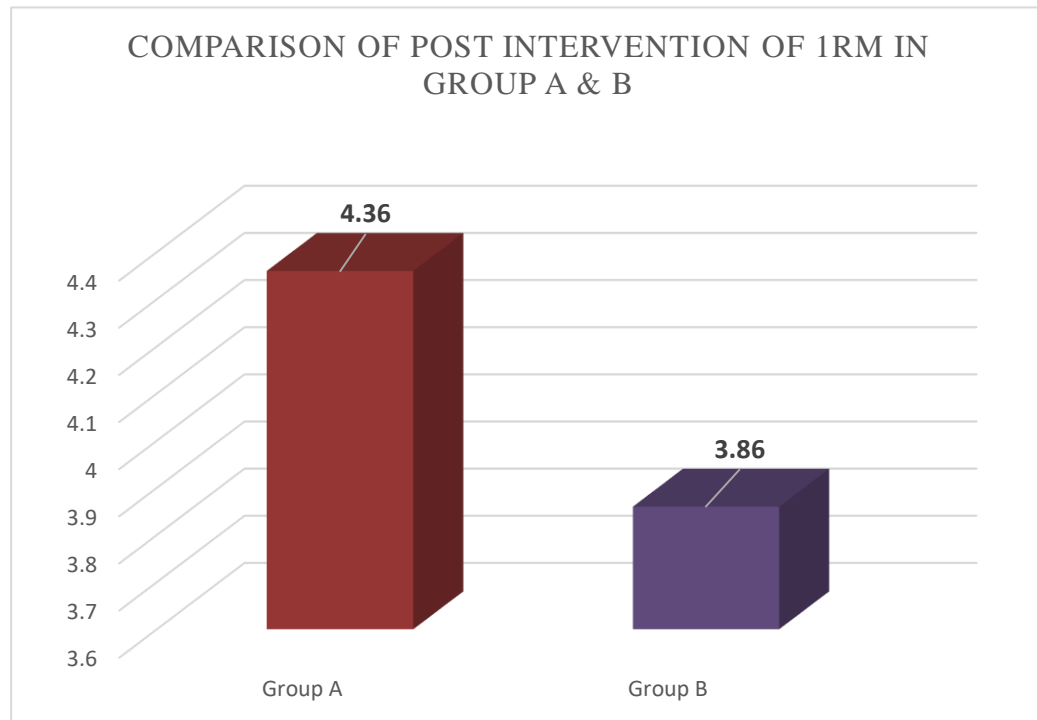
The table (**table no.2**) compares forearm circumference values of pre and post-intervention in groups A and B. Group A showed a highly significant mean difference of 2.22 (p-value=0.0002), while group B showed a non-significant mean difference of 0.23 (p-value=0.586). The pre-interventional values of Groups A and B were not significant(p value>0.999), indicating study homogeneity. Post-intervention values of Groups A and B, the difference was of great significance. (p - value= 0.001). This indicates that Group A achieved a remarkably improved result than Group B. (**Graph no.1**)

1 RM			
Groups	Pre-Treatment	Post- Treatment	P- value
	Mean and SD	Mean and SD	
Group A	3.32±0.69	4.36±0.729	<0.0001*
Group B	3.32±0.6904	3.86±0.715	0.009*
P- value	>0.999#	0.0180*	

Table no.3: 1 Repetition Maximum

*– extremely significant

#– not significant



Graph no.2: Shows comparison of Post values of 1RM in group A and B

The table (**Table no.3**) compares 1 RM values of pre and post-intervention in groups A and B. Group A showed a highly significant mean difference of 1.04 (p -value<0.0001), while group B showed a non-significant mean difference of 0.54 (p -value=0.009). The pre-interventional values of Group A and B were not significant (p -value>0.999), indicating study homogeneity. Post-intervention values of Group A and B, the difference was of great significance. (p -value= 0.0180).

This indicates that Group A achieved a remarkably improved result than Group B. (**Graph no.2**)

IV. DISCUSSION

Goal of the current investigation had been to analyze the impact on two distinct types of resistance exercises on dentists' forearm and grip strength of hand. The study results demonstrated both the exercises had improvement in circumference of the Forearm and 1RM, but group A that received eccentric exercise therapy showed a remarkable development in forearm performance level and maximal grip strength.

In the current research, eccentric training (Group A) resulted in a remarkable development for forearm circumference (p =0.001) and 1RM (p =0.0180) than grip exercise (Group B). A report by B. Svernlöv et al, concluded that Eccentric training have shown promise in significantly reducing symptoms for the majority of patients with lateral humeral epicondylalgia, regardless of duration, and may outperform traditional stretching methods in efficiency. [14]. They were introduced to an eccentric training program that showed a significant improvement in grip strength after 3 months (p <0.05)

Sangwon Kong et al recruited 18 subjects to study the hand exercises on forearm circumference and it was concluded that participants who performed grip exercise with softball after a 4-week period, had a remarkable development in their forearm circumference(p <0.001) of 23.6 ± 2.1 cm[15]. Jace Derwin et al added that gripping larger objects like barbells or dumbbells (crushing/power grip) requires increased force beyond regular squeezing, engaging both forearm extensors for wrist stabilization and flexors for gripping force[16]. This dynamic movement recruits various forearm muscles, enhancing hypertrophy of the forearm. Grip strengthening focuses on three main holds: (i)crushing,(ii) pinching, and (iii)support grip.

The present study focused more on tip pinch and palmar pinch grip exercises therefore Group B showed no significant improvement post-treatment ($p=0.058$) and had a mean forearm circumference of $22.996\pm 1.70\text{cm}$. The study concentrated on the palmar and tip pinch grip due to the ergonomic challenges posed by the handle design of dental instruments. This design requires increased muscle load and demands greater pinch force, largely due to the rigorous tasks involved in the dental profession [17,18].

A report by Giuseppe Coratella et al concluded that when the subjects were trained for eccentric-only exercise, the bench press 1RM had a remarkable development after six weeks ($p<0.05$) [19]. In the present study, there was a remarkable improvement on 1RM ($p=0.0180$) with an average 1RM as $4.36\pm 0.72\text{kg}$ post eccentric regime (Group A). When engaging in eccentric movements, the muscles of the forearm experience tension during the lengthening phase creating micro-tears in the muscle fibers, triggering a cascade of biological responses aimed at repairing and rebuilding the muscle tissue[20-22]. This leads to hypertrophy of the muscles of the forearm which translates into greater force production capabilities, allowing individuals to lift heavier weights and achieve higher 1RM values. This correlates with the study by Scanlan et al stating that an increase in forearm circumference has a correlation of $r=0.42$ with one repetition maximum(1RM) weightlifting in inexperienced female undergraduates. ($p<0.01$) [23]. In the present study, Group A had a remarkable development in the forearm circumference from 22.76 ± 1.35 to 24.98 ± 2.382 post eccentric regime($p=0.002$)

Incorporating eccentric strengthening exercises for the forearm musculature appears to offer promising benefits for ergonomic demands faced by dental professionals. Implementation of such strengthening protocols could potentially enhance muscular endurance, reduce the risk of overuse injuries, and contribute to overall ergonomic optimization within the dental workplace. More research and clinical trials are needed to fully understand the effectiveness and impact over time of eccentric strengthening in this population.

V. CONCLUSION

It was found that both varieties of exercise led to a significant improvement in forearm circumference and 1RM. Specifically, eccentric strengthening exercises were discovered to be notable in improving forearm strength among dentists. Implementing these exercises in regular clinical practice could help dentists maintain strong forearm muscles and prevent weakness, ultimately improving their overall performance.

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