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Effectiveness of upper limb strengthening exercises versus tendon gliding exercises with forearm stretching on handwriting speed and grip strength for undergraduate dental college students

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Abstract
This study addresses the problem of reduced handwriting speed and grip strength among undergraduate dental students, which can impact academic performance. It compares the effectiveness of upper limb strengthening exercises and tendon gliding exercises combined with forearm stretching in improving handwriting speed and grip strength. Forty students aged 19 to 22 were randomly assigned to two groups. Group A performed upper limb strengthening exercises, while Group B followed a tendon gliding and stretching routine. Both interventions were administered five days a week over a period of four weeks. Pre- and post-intervention assessments were conducted using the Words Per Minute test for handwriting speed and a hand dynamometer for grip strength. The results showed significant improvement in both groups; however, Group A demonstrated greater enhancement in both handwriting speed and grip strength. The study concludes that upper limb strengthening exercises are more effective than tendon gliding with forearm stretching for improving handwriting performance in dental students.

Keywords: Upper limb strengthening exercise, tendon gliding exercise, handwriting speed, grip strength

1. Introduction
Handwriting speed is essential for academic success, as it reflects the ability to express knowledge efficiently and is a core component of human communication, creativity, and cognitive development [1-3]. Despite increasing use of technology, handwriting remains a vital skill in education due to handwritten examinations [14]. Handwriting performance is influenced by several factors including anatomy, posture, joint position sensation, muscle strength and flexibility, as well as writing instruments and surfaces [1, 4-7, 13].
Muscle fatigue and slow handwriting can hinder academic performance and self-confidence, leading to reduced motivation and even learning difficulties [7-9]. Strengthening exercises for the upper limb improve muscle power, endurance, and tone through isotonic contractions, resulting in hypertrophy and enhanced performance [10]. Specifically, upper limb and hand strengthening may positively impact handwriting speed and grip strength, with improved musculoskeletal coordination leading to better academic outcomes [15].
Tendon gliding exercises, such as hookfist, fullfist, and tabletop, enhance fine motor control by promoting tendon excursion and flexibility, similar to how aerobic exercises benefit the heart [16]. Stretching complements these exercises by improving range of motion, power, and circulation while reducing fatigue and stress [17].
To assess these interventions, the study uses Words Per Minute (WPM) to evaluate handwriting speed and a hand dynamometer to measure grip strength-two reliable metrics for motor control and muscle endurance [20]. This study aims to establish a correlation between physical interventions (strengthening and tendon gliding/stretching) and writing performance, contributing practical strategies to enhance fine motor skills in undergraduate dental students.

2. Materials and Methodology
2.1 Materials Used
The following tools and instruments were utilized for intervention and assessment: pen, paper,

stopwatch, dumbbells, rubber bands, grip dynamometer (for measuring grip strength), a bell (for signal cues), and a structured assessment form.

2.2 Study Design and Setting
This study employed a quasi-experimental pre- and post-test design and was conducted at Sri Ramakrishna Dental College, Coimbatore, over a period of six months.

2.3 Participants and Sampling
A total of 40 undergraduate dental students aged 19-22 years were selected using a convenient sampling method. Subjects were randomly divided into two groups:

- **Group A:** Upper limb strengthening exercise
- **Group B:** Tendon gliding exercise with forearm stretching

2.4 Inclusion Criteria
- Age between 19-22 years
- Both males and females
- Normal BMI
- Tripod pen grip

2.5 Exclusion Criteria
- History of upper limb injury in the past 6 months
- Systemic illness, hand injuries, carpal tunnel syndrome, trigger finger
- Recent surgeries (within 2 months)
- Visual/hearing impairments
- Regular gym activity (more than 1 month)

2.6 Variables
- **Independent Variables:** Upper limb strengthening exercises; tendon gliding exercises with forearm stretching
- **Dependent Variables:** Handwriting speed; grip strength

2.7 Outcome Measures
- **Words Per Minute (WPM) Test:** To assess handwriting speed
- **Grip Dynamometer:** To measure grip strength

2.8 Treatment Procedure
Each participant underwent a single 30-minute session per day, five days per week, for one month. Group A followed a protocol of upper limb strengthening exercises targeting the forearm and intrinsic hand muscles. Group B performed tendon gliding exercises and forearm stretching routines designed to improve flexibility and endurance. Pre- and post-test assessments were conducted using the WPM test and grip dynamometer to evaluate outcomes.

Note: All tools and procedures used were standard and reproducible. No tables, figures, or procedures were adapted or borrowed from external copyrighted sources.

2.9 Intervention
Group A: Upper limb strengthening exercises

Table 1: Structure exercise

Muscle	Exercise	Material/Position	Repetition
Biceps	Strengthening	Dumbbell	10*3
Brachioradialis	Strengthening	Dumbbell	10*3
Wrist extensor	Strengthening	Dumbbell	10*3
Thenar eminence	Endurance	Rubber band	10*3
Hand, forearm	Endurance	Praying	10*3

Group B

Table 2: Tendon gliding exercises

Position	Repetition
Straight hand	5sec hold *10rep
Hook fist	5sec hold *10rep
Full fist	5sec hold *10rep
Tabletop	5sec hold *10rep
Straight fist	5sec hold *10rep

Forearm stretching
Stretching of Wrist flexors and extensors 30 seconds in stretching positions and 30 seconds in positions of release with elbow extended.5 repetition 2 time per day

3. Results
Pre-test and post-test values of the study were collected and assessed for variations in improvement and their results were analysed using independent t test and parried t test. The statically analysis of the study showed that there is a significant difference between the groups in WPM test and hand 450ynamometer with a t value of WPM test test and hand dynamometer was 2.042.

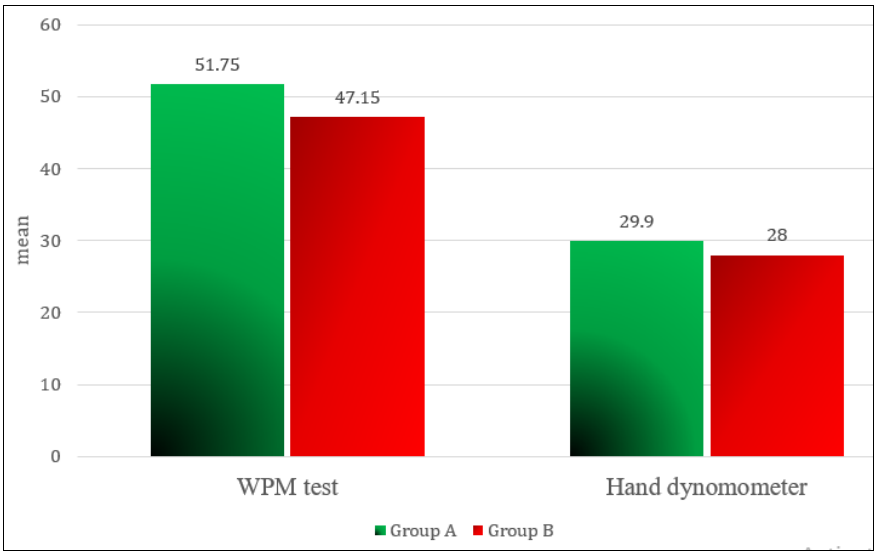

Fig 1: Comparison of results

4. Discussion

This study demonstrated that upper limb strengthening exercises are more effective than tendon gliding exercises combined with forearm stretching in enhancing handwriting speed and grip strength among undergraduate dental students. Group A, which performed upper limb strengthening exercises, showed greater improvements in both outcomes, with statistically significant differences in pre- and post-test results. Handwriting speed and grip strength increased more in Group A compared to Group B, as reflected by higher mean differences and t-values. These results highlight the importance of targeted strengthening exercises in developing fine motor skills essential for dental tasks.

5. Conclusion

The conclusion of this study is based on the post mean measure of words per minute test and hand dynamometer of both group A and group B and concluded that there is a significant improving the handwriting speed and grip strength in group A, in comparison with the students in group B.

As per data analysis and interpretation, null hypothesis (H0) is rejected, and the alternate hypothesis (H1) is accepted which states that There is significant improvement on upper limb strengthening (Group A) than tendon gliding exercises with forearm stretching (Group B) on increase handwriting speed and grip strength.

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