Original Article

Effect of hand exercises on grip strength and manual dexterity in children with severe congenital visual impairment

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ABSTRACT

Background: Vision is important in planning and performing motor skills. Early reduction or lack of visual function may alter or delay the development of basic motor and visual-motor skills. Developing skilful hands is a necessity in blind children as it often compensates for their missing vision. **Objective:** The objective of the study was to focus on the efficacy of hand exercises on grip strength and manual dexterity in children with severe congenital visual impairment. **Materials and Methods:** The study included 60 children aged 7–15 years who were diagnosed with severe bilateral congenital visual impairment. Hand exercises were given to all the 60 children at least 4 days in a week for a period of 6 weeks. Grip strength and manual dexterity values were analyzed using Jamar dynamometer and Purdue Pegboard test, respectively. **Results:** The mean age was 12.15±2.284 years. We observed a significant improvement in grip strength ($p<0.001$) and manual dexterity ($p<0.001$) post-intervention as compared to the pre-intervention scores. **Conclusion:** The findings of the present study indicate that hand exercises can be a useful training method in improving grip strength and manual dexterity in children with severe congenital visual impairment.

Key words: Congenital visual impairment, Grip strength, Hand exercises, Manual dexterity

Visual capacity of the central nervous system in humans progressively develops from birth. Development of the visual system immediately starts after birth via visual stimuli and interactions with the environment, which concomitantly occur with the child's global development [1]. The World Health Organization has categorized visual impairments with respect to the best-corrected visual acuity as follows: blindness (Snellen visual acuity of 3/30), severe visual impairment (Snellen visual acuity between 6/60 and 3/30), moderate visual impairment (Snellen visual acuity between 6/18 and 6/60), and mild or no visual impairment (Snellen visual acuity of 6/18) [2].

Childhood blindness is a public health concern across the world. Global estimates on childhood blindness show that there are around 1.42 million and 17.52 million children suffering from blindness and moderate to severe visual impairment, respectively [3]. Young children with visual impairment and blindness often lack hand strength, explore only parts of objects and generally experience delays in the development of their fine motor and object manipulation skills when compared to their sighted peers [4]. Motor skill difficulties found in children with visual impairment may include a change in delay in the construction of the corporal scheme and in the acquisition of functional habits, such as dressing and eating in addition to changes in manual dexterity and gross motor skills [5].

Theraputty exercise is a form of finger and grip strength training. It can be formed into various shapes, providing a well-balanced exercise program. Theraputty delivers a simple and effective resistance based training which helps to develop a strong, capable grip [6]. The Jamar dynamometer is the most widely reported device used to measure grip strength. It displays grip force in both pounds and kilograms, with a maximum of 200 lb (90 kg). The Jamar test is isometric, with no perceptible motion of the handle, regardless of the grip strength applied. The Jamar dynamometer presents good inter-rater reliability and test-retest reliability [7]. The Purdue Pegboard Test is a standardized test that measures finger and hand dexterity. The Purdue Pegboard Test was developed by Joseph Tiffin in 1948. The test measures the gross motor dexterity of hands, fingers, and arms, as well as the fine motor dexterity of fingertips [8].

In literature, studies have mentioned about the promising results obtained from hand exercises on grip strength and manual dexterity in different population groups [9,10]. However, there is a need to address similar issues in visual handicaps as hand serves as a primary information-gathering tool for them. Therefore, the

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present research aimed to determine the effect of hand exercises on grip strength and manual dexterity in children with severe congenital visual impairment.

MATERIALS AND METHODS

This prospective study was carried out in the blind schools and societies of Pune over a period of 3 months. Approval from the Ethical Committee of Rangoonwala College of Physiotherapy, Pune, was obtained before starting the research. A written consent was taken from the guardian/parents of the children before the commencement of the study. The subjects were enrolled in the study based on convenient sampling. Sixty children with a severe bilateral congenital visual impairment aged between 7 and 15 years were included in the study. Children with a recent hand injury and any neurological or recent orthopedic problems related to hand were excluded from the study. Hand exercises were performed using Theraputty. The sessions were individualized with the therapist and the subject sitting in a comfortable position opposite to each other. The subjects were asked to perform exercises with one hand at a time, except for the last exercise which required using both hands. Appropriate progression was made by changing the resistance of the Theraputty starting with extra soft in the first 2 weeks followed by soft in the next 2 weeks and progressing to medium for the last 2 weeks. The hand exercises, as illustrated in Table 1, were given 4 times in a week for a total period of 6 weeks to each of the subject. Grip strength and manual dexterity values were analyzed before and after the intervention using Jamar dynamometer and Purdue Pegboard test, respectively.

Statistics

Descriptive and inferential statistical analyses were carried out in the present study. Results on continuous measurements were presented as mean±SD and results on categorical measurements were presented in number (%). The level of significance was fixed at p=0.005. Paired t-test was used to find the significance of study parameters on the continuous scale within the group at different time intervals. The Statistical software IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA) was used for the analyses of the data.

RESULTS

All 60 subjects completed the study and the mean age was 12.15±2.28 years. Table 2 shows the improvement in the mean values of Jamar dynamometer. In the right hand, improvement was 14.92–18.08 and for the left hand, it was 9.95–12.24 after 6 weeks of intervention and this difference was highly significant using paired t-test (p<0.001).

Table 3 shows an improvement in the mean values of Purdue Pegboard test for its 4 components. For the first component, mean value was improved for a right hand from 8.8 to 13.28, for the left hand from 5.92 to 9.1, for both hands from 4.12 to 6.63, and for assembly from 12.25 to 21.12 after 6 weeks (p<0.001).

DISCUSSION

The present study was targeted to find the effect of hand exercises on grip strength and manual dexterity in children with severe congenital visual impairment. The outcomes used were Jamar dynamometer and Purdue Pegboard test to evaluate grip strength and manual dexterity, respectively. Research on visual handicaps has emphasized on the adapted kinetic intervention program and its positive effect both on the overall kinetic development of children and adolescents with visual impairment as well as on their individual motor skills [11]. Aki *et al*. demonstrated the effectiveness of a motor training program for visually impaired children [12].

The results of the present study indicated that there was considerable improvement in grip strength with the hand exercises. A study conducted by Legg showed that strength initially increases due to neuromuscular adaptation associated with improved recruitment of motor units in skeletal muscle. Higher threshold motor units are recruited first and thus there is an increase in the maximal force generated in the muscles [13]. Another study done by Sathya *et al*. observed that following resistance exercise, there is a brief increase in protein synthesis within muscle. Performing exercise with increased resistance caused more protein synthesis in the muscles and increased the total volume of muscles [14].

Table 1: Hand exercises

Theraputty hand exercises	Repetitions	Sets
Finger flexion	20 reps	1 set
Metacarpophalangeal joint flexion	20 reps	1 set
Interphalangeal joint flexion	20 reps	1 set
Finger grip strengthening	20 reps	1 set
Finger abduction	20 reps	1 set
Rolling putty into ball and pinching it between thumbs and finger with both the hands	20 reps	1 set

Table 2: Effect of hand exercises on grip strength using Jamar dynamometer

Variables	Time interval	n	Mean±SD	t-value	p-value
Right hand	Pre	60	14.92±3.576	24.256	<0.001**
	Post	60	18.08±3.916		
Left hand	Pre	60	9.95±3.280	21.120	<0.001**
	Post	60	12.48±3.270		

Table 3: Effect of hand exercises on manual dexterity using Purdue Pegboard

Variables	Time interval	n	Mean±SD	t-value	p-value
Right hand	Pre	60	8.80±3.424	14.889	<0.001**
	Post	60	13.28±3.774		
Left hand	Pre	60	5.92±3.504	15.117	<0.001**
	Post	60	9.10±3.821		
Both hands	Pre	60	4.12±1.914	18.295	<0.001**
	Post	60	6.63±1.904		
Assembly	Pre	60	12.25±6.103	20.489	<0.001**
	Post	60	21.12±6.541		

The results of this study also emphasized on the effectiveness of hand exercises on manual dexterity. Improved manual dexterity could possibly be explained by an improvement in the grip strength scores. The results obtained can be discussed based on a study done by Martin *et al*., which showed that dexterous actions that rely on the fast and precise coordinated movement control of the hand, wrist, elbow, and shoulder, such as that of aiming and tapping, appear directly associated to hand grip strength. Reduced strength leads to an increase in the variability of force capability, causing increased variability to the movement trajectory and the accuracy of the final position. The author also suggested that strength exercises in adults may be a simple preventative measure against hand dexterity decline [15].

The limitation of the present study was that Purdue Pegboard test was used to measure the manual dexterity, the reliability, and implications of which are not widely studied in visually impaired children as compared with the healthy population.

CONCLUSION

A significant improvement in grip strength and manual dexterity was seen after 6 weeks of hand intervention. Thus, hand exercises can be considered as a useful training method in improving grip strength and manual dexterity in children with severe congenital visual impairment.

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