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†TRAINING ELDERLY FOR MOBILITY AND STRENGTH USING EMG-BIOFEEDBACK AND SWISS BALL/ PEANUT BALL EXERCISES.

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Abstract :

Objectives of the Study: *To investigate the efficacy of sEMG biofeedback and swiss ball/ peanut ball exercises in O.T Gericare training program for improving strength and balance and their influence on subjective functional wellbeing.*

Methodology: *A clinical study was conducted with 21 healthy geriatric individuals for 12 weeks. Individuals were assessed on: 1} Performance Oriented Mobility Assessment {POMA} for mobility and balance, 2} Manual muscle Testing for b/l Tibialis anterior {TA}, Back Extensor {E}, and b/l Rectus Femoris {RF} muscles,3} COOPS/ WONCA charts for subjective functional wellbeing.*

Treatment *consisted of two medias: 1} Swissball/ peanut ball, 2} sEMG biofeedback {for initial 8weeks to train TA, E and RF muscles} in the conventional O.T training program divided in to four phases-P I- static, PII- semidynamic, PIII-dynamic, PIV-functional, along with home program.*

Results: *Very highly significant results {Pvalue< .000} were noted on POMA scale, muscles strength and COOPS/ WONCA charts post 12 weeks of training program.*

Very highly significant co-relation {P<.000} was found between improvement in ® TA and E muscle strength with decline in functional inability.

Conclusion: *Comprehensive preventive program with inclusion of sEMGBF and ball exercises to improve strength and balance for geriatric population is beneficial for improving their functional wellbeing.*

Keywords : Gericare, strength training, balance training, Surface EMG biofeedback, preventive program, functional wellbeing

INTRODUCTION

India is a growing nation with growing number of elderly population.

The reference IV of the eleventh five year plan (2007- 2012) reviews the challenges of immediate future, such as aging population. The major area of concern is providing preventive, curative and rehabilitative services.[1]

Falls are the major problems in the geriatric population and are considered as "Geriatric Giants". It has been stated that the high morbidity and mortality rate in elderly are due to falls because of the poor physical and cognitive status.

Physical activities and a stress free life style are important for being psychophysically fit in old age.[2]

Therefore, there is a need for a well designed "preventive program" for elderly population which shall improve their strength, prevent falls and make them productive in the community.

The balance strategy shifts more proximally with age i.e. older individuals tend to use hip strategies as compared to the younger who use ankle strategies. The cause of this is inability of Tibialis anterior muscle to show required activity in the forward perturbation. Therefore, Tibialis anterior training helps in improving postural control.

Quadriceps group of muscles tends to weaken by 40% as the age advances. Therefore, quadriceps strengthening exercises are essential in elderly subjects.

As age advances the postural changes that are most commonly seen is kyphotic tendency due to the weakness of the erector spinae muscles. Therefore, training these muscles become requisite for overall improvement in balance as well reducing low back ache.

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This Study therefore proposes use of:

- EMG biofeedback as an adjunctive therapy
- Swiss ball/ Peanut ball for core stabilizing exercises.
- Functional activities

The study intends to improve functioning of elderly individual over the age of 60 years with the use of strength training and balance training exercises along with functional exercises. Improving level of confidence and quality of life in elderly will make them less prone for falls and prevent secondary complications in the long run.

AIMS AND OBJECTIVES OF THE STUDY:

1. To examine whether the **12 weeks** strength and balance training protocol with home program is effective in normal geriatric population in improving their balance and mobility skills.
2. To study the efficacy of **sEMG biofeedback** as an adjunct to conventional occupational therapy in re-educating muscles to improve posture and balance.
3. To evaluate whether there is subjective improvement of **functional capacity** in normal elderly population.

REVIEW OF LITERATURE

Judge J.O et al. 1993 did a study on exercises to improve gait velocity in older persons on 31 residents for 12 weeks which included resistance and balance training. They concluded that short term exercise program that trained strength and balance achieved a clinically significant improvement in gait velocity.3

Judge J.O. et al; 1994, in study conducted on the community dwelling men and women 75years and older were given 45 minutes of balance training for three times in a week for three months. Exercises were done with the use of Medias like computerized balance platform and floor based exercises. The results showed improvement in single leg stance, functional base of support and the sensory organization test of balance function, but no change in strength.[4]

Shumway –Cook. et al; 1997 studied the effects of multidimensional exercises like lower limb strength and flexibility exercises, static and dynamic balance exercises and aerobic activity in elderly population aged 65 yrs and above. Multidimensional exercise improved balance abilities and reduce falls.[5]

Movitz R.{2003} conducted the study to determine if a 12 weeks strength training program designed to improve lower body functions can also improve static balance and well being of the subjects.The study results indicated that lower body resistive training program is effective in improving lower body functions, static balance and subjective well being. [6]

Rogers M., et.al. {2003} studied the effects of the Theraband TM exercises and ball training in lying/ sitting in the individuals aged 61-77yrs. The exercises included stretching, strengthening and balance exercises. Balance exercises were performed on a 55 cm diameter air filled balls and moved in different directions with eyes open and closed. The results found were that the older individuals improved in postural sway and functional reach.[7]

METHODOLOGY

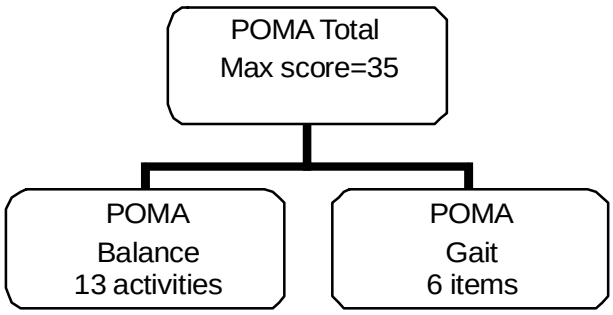
- ***Subjects***: 21 individuals over 60years of age out of which 16 participated and 5 dropped out.
- ***Materials required***:

  Stop watch, Measure tape, Peanut ball/ Swiss ball, Micro pore tape {1"}, Conducting gel
- ***Inclusion criteria***:
  - Elderly individuals aged 60years or more
  - Ambulatory individuals
  - Score of <25 on "PERFORMANCE ORIENTED MOBILITY ASSESSMENT"
- ***Exclusion criteria:***
  - Individuals with frank neurological disorder
  - Uncontrolled hypertension/ diabetes
  - Peripheral neuropathy
  - Uncorrected visual disparity
  - Active inflammatory disease
  - Inner/ middle ear disorders
  - No obvious cognitive disability
  - Acute musculo -skeletal disorder
- ***Apparatus used***:
  - **Biotech Surface EMG Biofeedback** with **NUROCARE 2000** software
- ***Study design***:
  - Prospective study
  - same subject pre and post interventional study
  - sessions : 2/ 3 times in a week and each session lasted for 45mins to 60 minutes.

TESTING PROTOCOL:

- ***Performance Oriented Mobility Assessment***

{POMA}: [8]



- ***Manual Muscle Testing:*** the 0-5 grading was used for Tibialis Anterior {TA}, Rectus Femoris {RF}, and Erector Spinae {E} before and after the study protocol for 12 weeks.[9]

- ***A Dartmouth COOP functional assessment charts/ WONCA {1995}***: This is the self reported and simple questionnaire, comprising of six charts. The scoring involves 5- point scale: 1= very good, 2= good, 3= moderate, 4= bad, 5= very bad. [10,11,12]

OCCUPATIONAL THERAPY INTERVENTION

- Medias used for intervention
  - Swiss ball/peanut ball exercises
  - Surface EMG biofeedback

The swiss ball/ peanut ball exercises

- **PHASE I***: static exercises* eg: Sitting on peanut ball with –eyes open, eyes closed, support, without support, Prone on peanut ball with elbow flexed and extended etc.
- **PHASE II**: *static to semi dynamic exercises* eg: Prone extension on roll, Wall slides with ball behind the back, etc
- **PHASE III**: *semi dynamic to dynamic exercises* eg: abdominal curl ups in hook lying position, quadruped exercises with contra lateral and ipsilateral patterns, etc
- **PHASE IV**: *dynamic to functional tasks* eg: Get up and go on a ball, Obstacle course, peg transfers while on the ball ,etc

EMG biofeedback training protocol

- The biofeedback training was given for initial 8 weeks.
- The base-line activity of the selected three muscles viz- Tibialis Anterior {TA}, Rectus Femoris {RF}, and Erector Spinae {E} was noted for each and then the training was started.

RESULTS

DATA COLLECTION

This experimental study was conducted on the 16 elderly healthy individuals of **age >60** years for the period of 12 weeks.

The outcome measures were balance, gait, muscle strength and objective functional improvement after **12 weeks** of therapy protocol.

Statistical tests applied:

➔ ***Paired 't' test***

➔ ***Pearson's coefficient of correlation***

STATISTICAL ANALYSIS

- The mean score of 17.43 and 30.81 were obtained pre and post intervention respectively on total POMA scale pre and post intervention. The results were **very highly significant** {t=24.19} at p=<0.000. This implies that the subjects on an average, who were at high risks of fall improved in their mobility following the 12 weeks protocol.
- The mean scores on Balance sub-component of POMA pre therapy was 13.25 and post therapy was 22.81. The results were **very highly significant** {t= 22.18} at p= <0.000
- The mean scores on the gait sub component of the POMA scale initially noted was 4.18 pre- therapy and post-therapy was noted to be 13.13. The results were **very highly significant** at p= < 0.000.
- The balance and the gait performance improved significantly after the 12 weeks of exercise protocol.
- The mean scores of the time components on the POMA scale noted on side by side standing balance, R leg unsupported stand, L leg unsupported stand, semi tandem stand and tandem stand were 7, 3.6, 3.5, 6.64, and 5.79 pre therapy and 9.5, 4.93, 4.95, 9and 8.5 post therapy respectively. The results were found to be **very highly significant** at p= <0.000.
- The mean strength in the {R} and {L} TA muscle was found to be 4.22 and 4.37 respectively pre therapy. The post therapy mean strength was 4.95 bilaterally. The results were **very highly significant** at p=<0.000.This implies that the subjects were able to combat minimal resistance prior to the therapy and then were able to perform at maximal resistance post therapy.
- The mean strength in rectus femoris {R} muscle of 3.89

and 4.31 was noted in {R} and {L} side pre therapy respectively which improved to 4.47 and 4.51 in {R} and {L} side respectively post therapy. The results were **very highly significant** at p=<0.000. This implies that the subjects were able to combat minimal resistance prior to the therapy and were later were able to take maximal resistance bilaterally post therapy.

- The mean strength in erector spinae {E} of 2.68 was noted pre therapy and 3.75 post therapy. The results were **very highly significant** at p= <0.000. This implies that the subjects could perform much better in trunk extension tasks post 12 weeks of training.
- The mean score of 20 was noted before the therapy on COOPS/ WONCA charts and that noted after the therapy was 13.3. The results were **very highly significant** {t= 12.66} at p= <0.000. This drop in the scores indicate that the difficulties functional performance of the subjects thus, making them more efficient after the 12 weeks of training protocol.
- No correlation between the POMA T and the COOPS/ WONCA scores was noted post therapy. This implies that the improvement in mobility as assessed on POMA was independent of the gain in functional independence of the elderly subjects.
- The negative correlation between the {R} TA strength and COOPS/ WONCA scores post therapy was obtained, r= -0.690 which was **highly significant** at p=< 0.001.This implies that improvement in the {R} TA strength led to the decrease in the functional incapacity as noted by the decreased score on COOPS/ WONCA scale.
- There was no correlation between the Q strength improvement and the subjective functional improvement

Table-1
Showing the Mean Values on the Performance Oriented Mobility Assessment Pre and Post Intervention

		Mean scores { X }	Standard deviation {SD}	T {paired}	P value
POMA total	Pre	17.43	2.21	24.19	<0.000 **Very highly significant**
	Post	30.81			
POMA B	Pre	13.25	1.70	22.18	<0.000 **Very highly significant**
	Post	22.81			
POMA G	Pre	4.18	1.16	13.137	<0.000 **Very highly significant**
	post	8			

{POMA B= POMA balance component; POMA G= POMA gait component}

Table-2
The Pre and Post Mean Scores of Timed Sub-Components on the Poma Balance Components

		Mean {X} in seconds	Standard deviation {SD}	T paired	P value
5b	pre	7	1.39	7.22	<0.000 **Very highly significant**
	post	9.5			
7b	Pre	3.6	0.60	9	<0.000 **Very highly significant**
	Post	4.93			
8b	Pre	3.5	0.68	8.52	<0.000 Very highly significant
	Post	4.95			
9b	Pre	6.64	1.29	7.31	<0.000 **Very highly significant**
	Post	9			
10b	Pre	5.79	1.37	1.88	<0.000 **Very highly significant**
	post	8.5			

{5b=side-by-side standing balance; 7b= R leg unsupported stand, 8b=L leg unsupported stand; 9b= semi tandem stand, 10b= tandem stand}

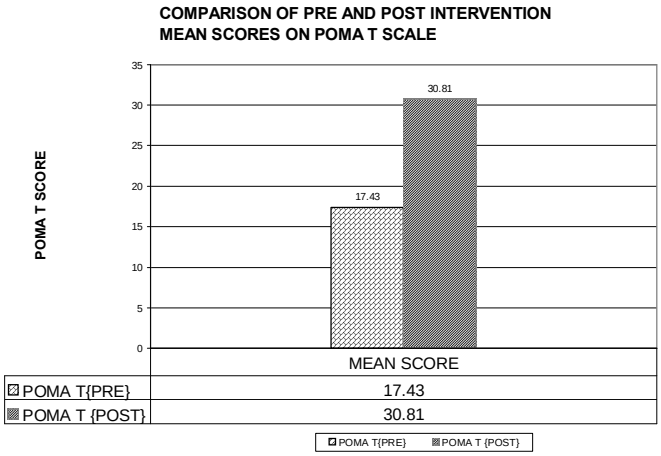
Table-3
Muscle Strength of both the Sides of the Body in the Tibialis Anterior {Ta}, Rectus Femoris {Rf}, and Erector Spinae {E} Pre and Post Intervention

		Mean strength {X}	Standard deviation {SD}	T paired	P value
TA {R}	pre	4.22	0.32	9.12	<0.00 **Very highly ignificant**
	post	4.95			
TA {L}	Pre	4.37	0.26	9.07	<0.000 **Very highly ignificant**
	post	4.95			
RF {R}	Pre	3.89	0.34	7.76	<0.000 **Very highly ignificant**
	post	4.47			
RF {L}	Pre	4.31	0.32	7.60	<0.000 **Very highly ignificant**
	post	4.91			
E	Pre	2.68	0.25	16.96	<0.000 **Very highly ignificant**
	post	3.75			

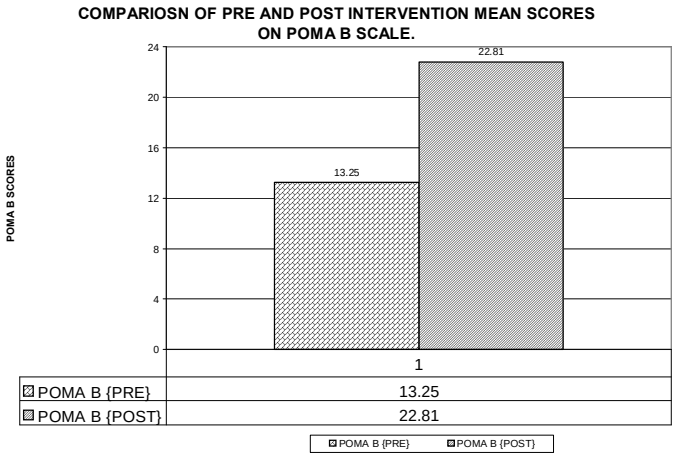
Table-4
Mean Scores on Coops/Wonca Scale Pre and Post Intervention

Coops/ WONCA	Mean {X}	Standard deviation {SD}	T paired	P value
Pre	20	2.09	12.66	<0.000 **Very highly ignificant**
Post	13.3			

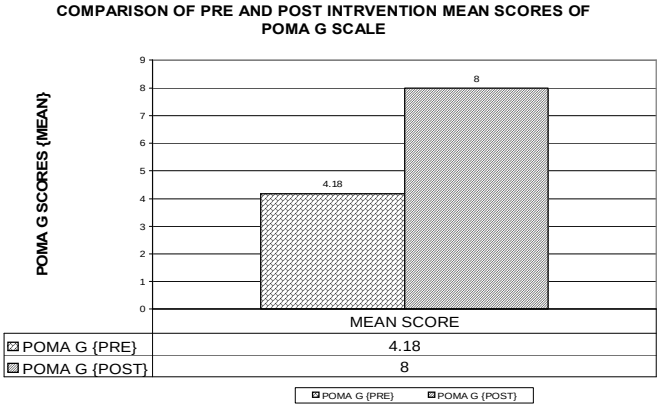
Graph 1



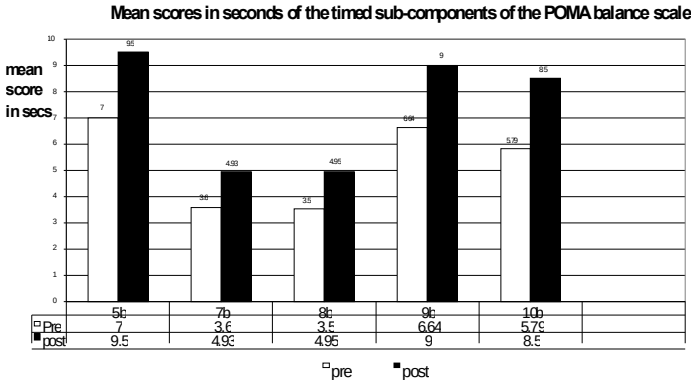
Graph 2



Graph 3



Graph 4



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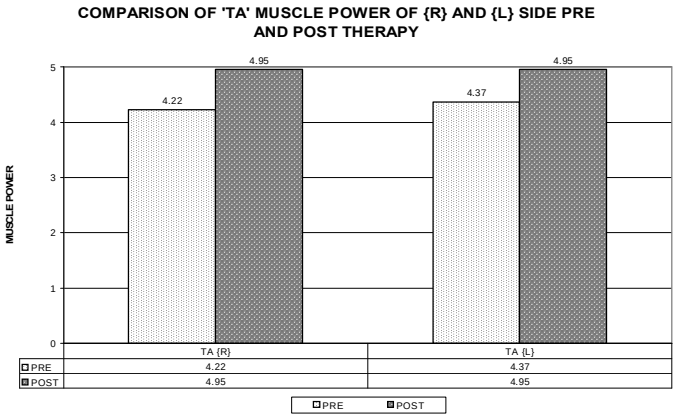
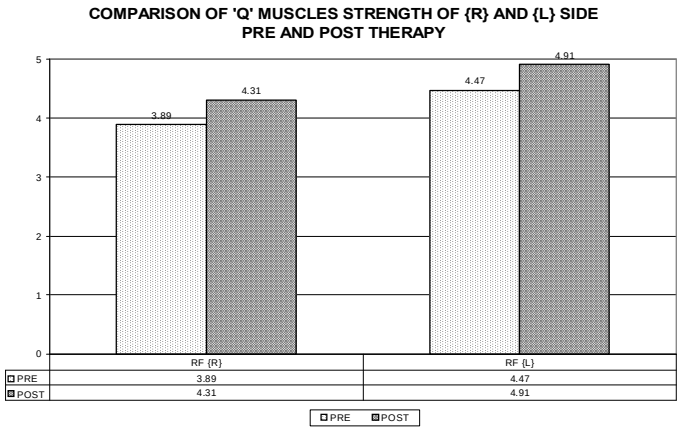
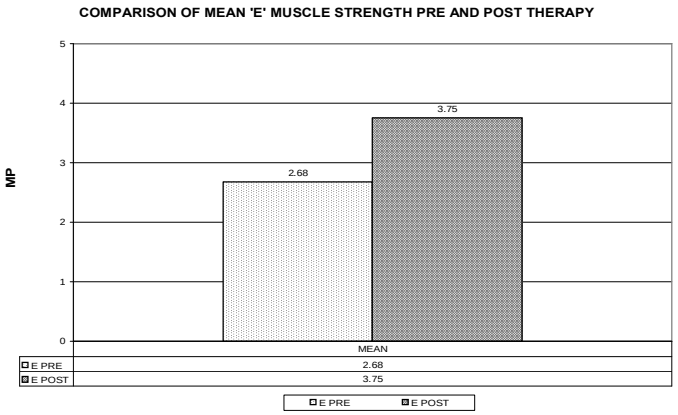


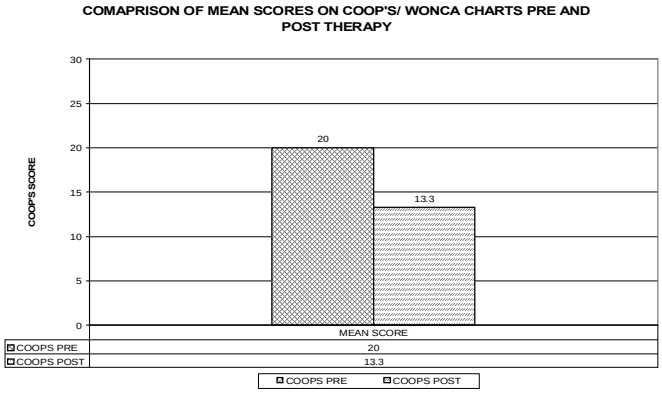
Graph 6



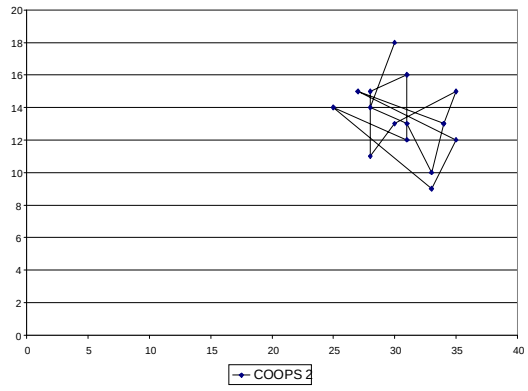
Graph 7



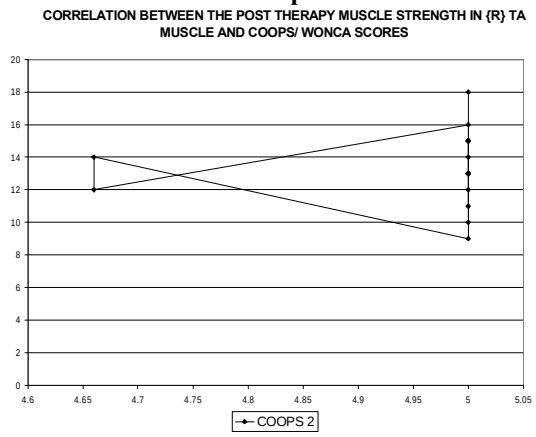
Graph 8



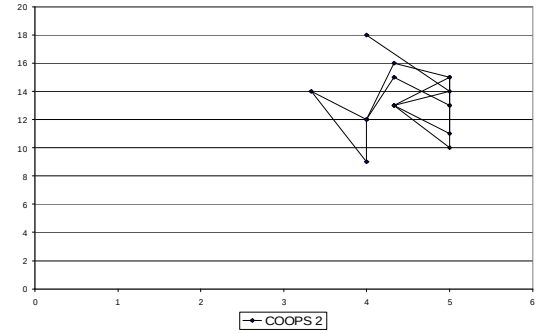
Graph 9



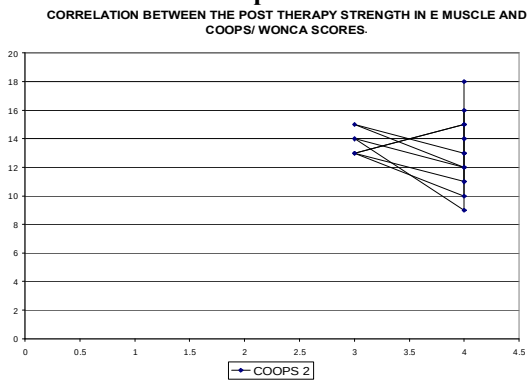
Graph 10



Graph 11



Graph12



as depicted by COOPS/ WONCA scores post therapy.

- There was the negative correlation between the E muscle strength and the COOPS/WONCA scores post therapy {r=-7.92} which is significant at p=< 0.000. This implies that there was **very highly significant correlation** between the improvement of E strength and the decrease in the functional inability as subjectively noted by elder individuals.

Summarizing the statistical analysis it is therefore, found that there was very highly significant difference between the pre and the post therapy scores on the POMA scale, muscle strength tested manually {for TA, Q, and E muscles} and the COOPS/WONCA scores individually. The negative correlation existed between the {R} TA and E muscle strength and COOPS/WONCA scores post therapy indicating improvement in functional activities post therapeutic intervention for 12 weeks.

DISCUSSION

This clinical study has been carried out to know the effectiveness of surface EMG biofeedback and spherical ball/ peanut ball as therapeutic modalities in training of elderly population above 60 years of age to improve their mobility, strength and functionality.

Significant results were obtained in the muscle strength of elderly population. This supported the proposition of **Simkins B {2002}** who in his study concluded that even frail individuals can be benefited with the strength training for major muscle groups.[13]

■ *Muscle strength-Tibialis anterior*

Tibialis anterior {TA} muscle strength improved significantly after the therapeutic intervention using EMG biofeedback and other functional activities as mentioned in the treatment protocol {p<0.000}.

In this study, training of Tibialis Anterior on sEMG biofeedback improved the strength of the muscle which would, in turn lead to effective force generation, adequate onset latencies and ankle strategies in elderly population. These would thereby prevent loss of balance.

■ *Muscle strength-Quadriceps*

In this study it was also found that strength in the quadriceps group of muscle significantly improved after the 12 weeks of treatment protocol. Use of sEMG biofeedback, weighted cuffs, and functional activities as mentioned in the exercise phase was effective in improving the knee extensor strength {p< 0.000}.

Judge O J, et al. {1994}concluded in their study that flexibility exercises and resistive exercises which improved gait velocity in older subjects. [4]

In a study conducted by Fiantarone {1994}, 189% increase in knee extensor strength was noted post exercises. [14]

Cannon et al.{2007} proposed in their study that resistance training program on peak isometric torque, muscle hypertrophy, voluntary activation and electromyogram signal amplitude {EMG} of the knee extensors improves the neuromuscular functions.[15]

■ *Muscle strength-Back extensors*

The results found were very highly significantly {p<0.000} which confirms that the activities provided were effective in improving the strength of back extensors. This was in turn found to improve posture in the subjects {not statistically proven}.

Similar prepositions were laid by Westcott W, Richard M. in their study using *Nautilus* low back machine. [16]

■ *Muscle strength in all*

In this study muscle strength improvement was found statistically significant in all the three muscles selected viz; Tibialis Anterior, Quadriceps and back extensor muscle. It is thus believed that the Occupational therapy intervention coupled with SEMG biofeedback and ball exercises are effective modes of training in elderly population.

Judge O.J. {1993}similarly concluded in his study that strength training program for hip, knee, and ankle musculature is effective. [3]

Westcott W, Richard M. found similar results in their study on strength training for lower extremity, upper extremity, back muscles and neck muscles which improved the body composition, muscle strength, joint flexibility, functional capacity and mobility in the elderly subjects. [16]

■ *EMG-biofeedback and ball exercises*

The intervention focused on balance training in this study. The use of sEMG biofeedback, ball exercises and functional activities were found to significantly improve the individuals' scores on mobility scale i.e. Performance Oriented Mobility Assessment {p<0.000}. The sub components of the scale assessing balance {POMA B} and gait {POMA G} also showed significant results individually post intervention {p<0.000}.

Therefore, use of sEMG biofeedback as an adjunct to Occupational Therapy program can trigger the effective balance abilities of older individuals.

Judge J.O et al. {1994} [4], Hinman, Martha R. {2002}[17], Cram J.R.[18], Howe J.{2001}[19] all propagate the use of EMG biofeedback training in their studies.

■ ***Spherical ball/physio-roll exercises***

Rogers M. Page P {2003}.has laid the guidelines for the use of spherical ball taking in to consideration *Size*, *Compliance* and *Degrees of freedom* [20]

In this study 2 degrees to 6 degrees of freedom i.e. from roll to spherical ball progression was used. Foam mattress was used for moderate compliance. Base of support {BOS} was gradually decreased. Multimodal approach, contralateral and ipsilateral patterns on the ball helped to gain internalized dynamic balance system in elder individuals.

Therefore, the use of air filled ball in conjugation with functional tasks was effective in increasing strength in anti-gravity trunk musculature, to increase postural awareness, and maintain good balance.

■ ***Timed components of POMA scale***

The side- by-side standing balance, single leg stance i.e. standing with {R} and {L} leg unsupported, semi tandem stand, and tandem stand improved significantly post 12 weeks of intervention {$p<0.000$}.

Judge J.O. et al {1994} found similar results in their study.[4]

■ ***COOPS/WONCA charts***

There was marked improvement in all the areas of the scale viz: physical fitness, change of health, feelings, daily activities, overall health and social activities of the elderly subjects. Subjective improvement was also noted in terms of level of confidence and decreased fear of fall after the training.

Binder et al{2002}[21]; Pirjo Kenjonen [22]; Shumway –Cook et al. {1997} [5]conclude similarly in their respective studies

■ ***Correlation:***

Correlation of COOPS/WONCA charts with POMA and MP of TA, Q, E. was done.

It was therefore, observed that improvement in strength of {R}Tibialis Anterior and Trunk extensor strength negatively correlated to the scores of COOPS/ WONCA charts. This implies that when the strength improves the functional dependency decreases hence, rendering the elderly individual more functional.

However, there was no significant correlation between the improved quadriceps strength and the functional improvement in the elderly individuals.

It therefore, cannot be stated that by this study that improved mobility or improved strength training individually would contribute to the improved functional outcome in the aged population.

But surely it can be affirmed through above study that; *the effective comprehensive training program in elderly should include the balance activities, strength training and functional activities to gain effective performance in elderly.*

■ ***Propositions***

sEMG biofeedback and spherical ball/physio-roll exercises as an effective tool in improving the balance and strength in older individuals.

■ ***Suggestions***

Safe environment for exercises

Inclusion of functional task along with exercise program should be done.

Effective home program should be given and explained tio the individuals

Studies to compare the effectiveness of short term vs. long term exercise programs should be conducted.

■ ***Limitations:***

The study was Institution based. Therefore many found it inconvenient for transportation.

Therefore, implementation of **"COMMUNITY BASED PREVENTIVE PROGRAMS"** is essential.

Attention towards individual physical condition and degenerative changes due to normal aging was also paid during the study while formulating home program.

"PREVENTIVE HEALTH CARE PROGRAM" is a needed to improve the functional performance of the elderly individual.

CONCLUSION:

"Preventive Health Training Program" devised in this study keeping in to account for the age related changes, environmental constraints and safety, and appropriate media for training has been proven effectual in elderly population above 60 yrs of age.

To conclude more positively the healthy older individuals will still stand strong in the society like pillars and will be contributors to the well being of the community because, ***Life begins at 60***!!!!

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