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Original Article

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Effect of Plantarflexor Spasticity and Ankle Joint Range of Motion on Sit to Stand Movement in Stroke Patients

Deepa Aggarwal*, Shefali Walia, Majumi M. Noohu*****

Abstract

Objective: The study was done to find out the relationship between plantarflexor spasticity, ankle joint range of motion with sit to stand kinematics and total time duration to complete sit to stand movement in stroke patients.

Methods: The study was of correlation design, with 35 stroke subjects (32 male, 3 female) carried out at different hospitals in New Delhi. Subjects were assessed for plantarflexor spasticity, plantarflexion and dorsiflexion range of motion of ankle joint and sit to stand movement. Sit to stand movement was videotaped and sit to stand kinematics and total time taken to complete the movement was analyzed through motion pro motion analysis software. Correlation between plantarflexor spasticity , ankle joint range of motion with sit to stand kinematics and total time duration to complete sit to stand movement determined using Karl Pearson's correlation coefficient.

Results: The results showed a strong positive correlation between plantarflexor spasticity and total time duration of sit to stand movement (r=0.81) and plantarflexion range of motion and total time duration of sit to stand movement (r=0.85). There was a strong negative correlation between dorsiflexion range of motion and total time duration of sit to stand movement (r=-0.80) Plantarflexion range of motion also has a moderate negative correlation with sit to stand kinematics in phase III of knee (r=-0.57) and phase III of hip (r=-0.33) respectively. Dorsiflexion range of motion also has a moderate positive correlation with sit to stand kinematics in phase III of knee (r=0.47) and phase III of hip (r=0.43) respectively.

Conclusion: The ankle impairments like plantarflexor spasticity and reduced ankle joint range of motion can affect sit to stand movement, so such impairments should be addressed during various therapeutic interventions.

Key Words: Plantarflexor spasticity; Ankle joint range of motion; Sit to stand movement; Kinematics.

Introduction

Stroke is a frequent cause of problem in body function, resulting in limitation on activity and participation.[1] Inability to stand up is common early on following stroke and predisposes the individual to further decreases in muscle strength and physical fitness, and to adaptive soft tissue changes, particularly in soleus muscle, associated with disuse and physical inactivity.[2] The ability to effectively sit to stand is a vital prerequisite for upright mobility.[3] It is biomechanically demanding, requiring more lower extremity joint torque and range of motion than walking and stair climbing.[4] Although executed in a small space and brief time, sit to stand is a movement of the whole body, involving a complete change in the interrelations of parts.

Central nervous system pathology may result in spasticity or a velocity dependent increase in stretch reflexes which contributes significantly to calf muscle hypertonia or stiffness.[5] Spastic hypertonia at the ankle

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joint is a major source of disabilities after stroke. Both reflex and nonreflex changes in ankles with spastic hypertonia can substantially affect the functional performance of stroke patients. Moreover, changes in ankle passive biomechanic properties could contribute to the internal ankle joint torque in functional movement, depending on the severity of spasticity.[6] Subjects with stroke have been found to have only half of dorsiflexion range of motion compared with healthy controls. Limited motion at the ankle may contribute to functional limitations, which are likely caused by the interaction of several complex factors such as spasticity, immobility, and structural adaptations.[6]

However, the ankle impairments of stroke patients on sit to stand performance are still undermined. Moreover, there is a lack of in-depth investigation on ankle impairments that affect sit to stand performance. It is also necessary to establish the dynamics of functional activities, such as rising to a standing position, as carried out by healthy individuals, in order to analyze and correct abnormality in individuals who have impairments.[7] According to Nuzik *et al*, during sit to stand the hip flexed during the first 40 % of the cycle and extended during the last 60 % of the cycle. The knee extended throughout the pattern of motion. The ankle moved toward dorsiflexion in the first 45 % of the movement cycle. The remainder of the motion was characterized by movement toward plantar flexion.[8] Electromyographic analyses of muscle activation during this task shows the following, presented in order of activation:

1. Tibialis anterior muscle: for preparatory placement of foot backward and tibial stabilization.
2. Simultaneous onset of activity in gluteus maximus, biceps femoris (hip extensors) and rectus femoris, vastus lateralis and medialis muscles (knee extensors); activity of extensors peaks at time thighs are lifted off seat.
3. Varying degrees of roles of gastrocnemius and soleus muscles for postural control.[2]

Hence, sit to stand needs exclusive attention in terms of evaluation and characterization. Thus, the purpose of this study was to study the extent of relationship between ankle impairments, including plantarflexor spasticity and decreased ankle joint range of motion in patients with stroke during sit to stand movement.

Methods

Thirty five subjects with stroke were recruited from Jaipur Golden Hospital, Bhagwan Mahavir Hospital and Maharaja Agarsen Hospital, New Delhi. The study was of correlation design and of single session lasting for 45 minutes. The set inclusion criteria for the study were subjects who had first episode of stroke, age between 40-80 years, time since stroke more than 6 months, able to rise from a chair independently, the subject should have a minimum score of 8 out of 16 in composite spasticity score and follow verbal commands. Subjects were excluded if they had any brainstem, cerebellar, or subcortical lesion, ankle joint pain, any other musculoskeletal or neurological disorder and had any perceptual deficit. A written informed consent was taken from subjects after the verbal explanation of the procedure and purpose of the study. The study was approved by research and ethical committee of ISIC Institute of Rehabilitation Sciences, New Delhi.

Subjects were assessed for plantarflexor spasticity on composite spasticity scale and passive ankle plantarflexion, dorsiflexion range of motion measured using universal goniometer. Composite spasticity scale is a 0-16 point ordinal scale, developed by Chan, which has been shown to be reliable and valid in people with stroke. It has 3 components: tendon jerk (ankle), resistance to full range passive joint displacement (e.g., ankle dorsiflexion) and clonus (ankle).[9] For measuring available range of motion at ankle subjects were seated on an elevated plinth. The

hip and knee were maintained at a constant 90 degree of flexion during the measurements. The subjects were instructed to relax while the ankle was passively moved in the plantarflexion and dorsiflexion direction to the end of the available range of motion with the subtalar joint in a neutral position. Fulcrum of goniometer was centered over the lateral aspect of lateral malleolus. Proximal arm was aligned with lateral mid line of fibula using head of fibula and for reference distal arm to be aligned parallel of lateral aspect of 5th metatarsal. Two trials were performed for each movement and the average value of the two recorded readings was considered for analysis.[10]

For studying the kinematics of sit to stand subjects were dressed in lycra shorts and skin markers were placed on the affected lower limb on lateral aspect of head of 5th metatarsal, lateral malleolus, lateral epicondyle of femur, greater trochanter and top of mid-iliac crest.[8] Subjects were made to sit on a bench without back and arm rest with subject's greater trochanter at the leading edge of the seat with bare foot and arms folded in across the chest.[11] The height of seat was adjusted according to the length of lower leg so that ankle, knee and hip joint of each patient was at 90 degrees in starting postion.[1] The subject's feet were kept shoulder width apart.[12] Subjects were instructed to look straight ahead and stand up at a comfortable speed when given the verbal command 'stand up' and were asked to perform three times sit to stand task in his own pace after execution of a single practice trial.[13] Camcorder was placed on a tripod stand at a distance of 4 meter at right angle to the plane of movement to capture the task of sit to stand in sagittal plane on hemiplegic side.[5,8] One trial for each subject was selected for analysis. Criteria for trial selection was 1) ability to view all the data points on each frame, 2) subjective appearance of the movement as smooth or natural, 3) feet flat in the beginning of the movement and 4) a clearly defined completion of the motion.[8] Video obtained was transferred to computer. Motion pro motion analysis software was used to calculate angles at ankle, knee and hip and total duration taken to complete task sit to stand movement. A two dimensional link segment model was used in kinematic analysis. Ankle joint excursion during the movement was measured by a line joining fifth metatarsal and lateral malleolus and line joining lateral malleolus and lateral femoral epicondyle, knee joint excursion was measured by line joining lateral malleolus and lateral femoral epicondyle and line joining lateral femoral epicondyle and line joining lateral femoral epicondyle and greater trochanter and hip joint excursion was measured by line joining the lateral femoral epicondyle to greater trochanter and greater trochanter to mid iliac crest.[16] Entire sit to stand was divided in to three phases for analysis based on different phases of sit to stand described by Schenkman *et al*.[7]

Flexion momentum phase, starts with start of movement of trunk flexion and finishes just before the lift of buttocks from chair seat, momentum transfer, phase in which the buttocks leave contact with the seat and ankles attain maximum dorsiflexion and extension phase comprising of extension of all joints of body followed and continued till the cessation of movement marked by absence of any movement at the pelvis.[14]

Data Analysis

Data was analysed using the SPSS (version 17.0) for Windows. Mean ± standard deviation of composite spasticity score, ankle joint range of motion, total time, ankle, knee and hip joint excursion during sit to stand was calculated.

Karl Pearson's correlation coefficient was calculated to find out correlation between plantarflexor spasticity and ankle joint excursion, plantarflexor spasticity and time taken to complete the movement, ankle dorsiflexion range and time taken , ankle dorsiflexion range and ankle, knee and hip excursion. The significance level was set at $p \leq 0.05$.

Table 1: Mean and standard deviation value of duration and kinematics of sit to stand

Serial no.	Variables	Mean ±s.d.(degrees)
1.	Ankle angle in phase I(A)1	106.74±6.90
2.	Ankle angle in phase II(A2)	100.91±7.08
3.	Ankle angle in phase III(A3)	115.40±6.98
4.	Knee angle in phase I (K1)	92.26±9.97
5.	Knee angle in phase I (K2)	99.83±10.69
6.	Knee angle in phase III (K3)	162.86±8.22
7.	Hip angle in phase I(H1)	122.14±18.18
8.	Hip angle in phase II(H2)	118.63±18.40
9.	Hip angle in phase III(H3)	166.97±8.65

Results

The mean ± s.d. of age of the sample was 57.91± 7.67 years, mean ± s.d. of composite spasticity scale score was 10.40±1.66, mean ± s.d., of plantarflexion range of motion was 40.14±3.86^{o}, mean ± s.d. of dorsiflexion range of motion was 8.06±2.80^{0} and m ± s.d. of total time duration of sit to stand 3.53±0.95 seconds. The mean±s.d. of ankle angle, knee angle and hip angle in different phases of sit to sand is tabulated in Table 1.

A strong positive correlation was found between plantarflexor spasticity and total time duration of sit to stand (r=0.81) which was significant. (Table 2, Fig 1) A weak negative correlation was found, between plantarflexor spasticity and ankle excursion in phase I (r=-0.25) and in phase II (r=-0.25) and no correlation was found, in phase III (r=0.05) which were non-significant. (Table 3) A strong positive correlation was found, between plantarflexion range of motion and total time duration of sit to stand (r=0.85)

Table 2: Correlation between plantarflexor spasticity and total time duration of sit to stand, plantarflexion range of motion and total time duration of sit to stand and between dorsiflexion range of motion and total time duration of sit to stand.

Variable	Time (r)
Composite spasticity scale score	0.812**
Plantarflexion	0.853**
Dorsiflexion	-0.808**

**significant at 0.01

Fig 1: Correlation between composite spasticity score with total time duration of sit to stand

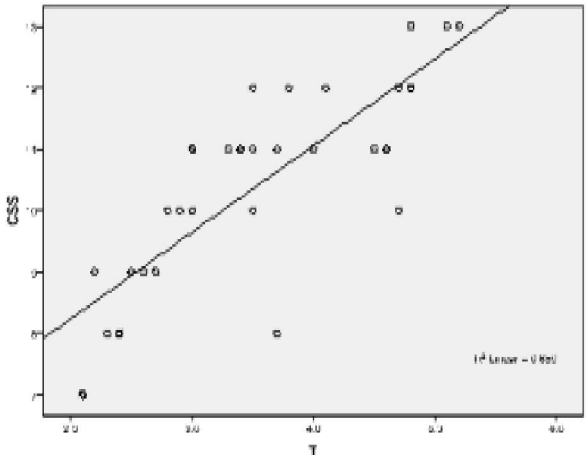


Table 3: Correlation between plantarflexor spasticity and ankle sit to stand kinematics

Variable	Ankle angle in phase I (r)	Ankle angle in phase II (r)	Ankle angle in phase II (r)
Composite spasticity score	-0.25	-0.25	0.05

Fig 2: Correlation between plantarflexion range of motion with total time duration of sit to stand

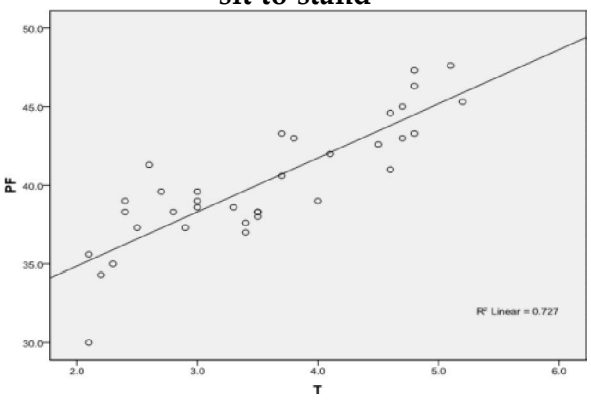
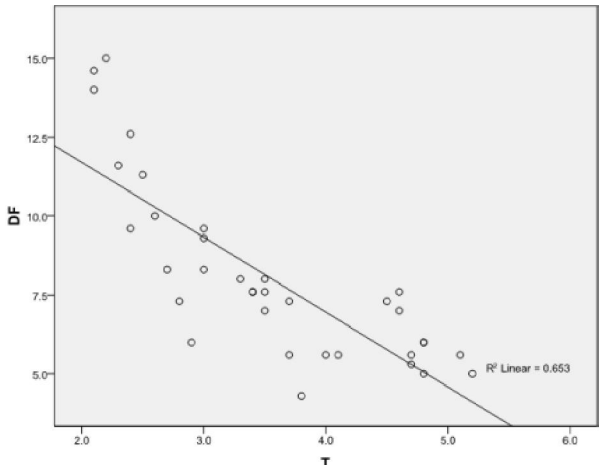


Fig 3: Correlation between dorsiflexion range of motion with total time duration of sit to stand



which was significant. (Table 1, Fig 2) A weak negative correlation was found between plantarflexion range of motion and ankle excursion in phase I (r=-0.29), in phase II (r=-0.27) and in phase III (r=-0.10) which were non-significant. No correlation was found, between plantarflexion range of motion and knee excursion in phase I (r=-0.09) and phase II (r=0.01) which was non-significant but moderate negative correlation was found with phase III (r=-0.57) which was significant. No correlation was found, between plantarflexion range and hip excursion in phase I (r=0.03) and in phase II (r=0.02) which were non-significant, but a moderate negative in phase III (r=-0.33) which was significant. (Table 4)

A strong negative correlation was found, between dorsiflexion range of motion and time taken to complete sit to stand (r=-0.80) which was significant. (Table 2, Fig 3) A weak positive correlation was found, between dorsiflexion range of motion and with ankle excursionin phase I (r=0.21), phase II (r=0.24) and phase III (r=0.15) which were non-significant. A very weak negative correlation was found, between dorsiflexion and knee kinematics excursion phase I (r=-0.13) and phase II (r=-0.17) which were non-significant but moderate positive correlation was found, between dorsiflexion and with knee excursion in phase III (r=0.47) which was significant. A very weak positive correlation was found, between and hip joint excursion in phase I (r=0.17), phase II (r=0.18) which were non-significant but moderate positive correlation was found, in phase III (r=0.43) which was significant. (Table 4)

Discussion

The results showed that there was a strong positive significant correlation between plantarflexor spasticity and total time duration of sit to stand, interpreted as more the plantarflexor spasticity more time it will take to perform sit to stand movement. Richards *et al* who noted that time taken to perform sit to stand in hemiplegic subjects was more as compared to healthy subjects.[15] Unlike total time duration, result showed that there is weak non-significant correlation between plantarflexor spasticity and ankle excursion in all phases of sit to stand, interpreted as there is no effect of plantarflexor spasticity on ankle excursion in sit to stand as most of the ankle angle in phase I and phase II are dorsiflexion than plantar flexion and which can be explained by the results of study done by Sahrmann and Norton *et al* who demonstrated that impairment of movement following stroke is not primarily due to reflexes

Table 4: Correlation between ankle joint range of motion and sit to stand kinematics

	A1 (r)	A2 (r)	A3(r)	K1 (r)	K2(r)	K3(r)	H1(r)	H2 (r)	H3(r)
PF	-0.291	-0.276	-0.105	-0.099	0.010	-0.574**	0.037	0.021	-0.336*
DF	0.218	0.249	0.153	-0.130	-0.171	0.477**	0.171	0.184	0.436**

*significant at 0.05,**significant at 0.01,

PF- Plantarflexion,DF- Dorsiflexion,A1- Ankle angle in phase I,A2- Ankle angle in phase II,A3- Ankle angle in phase III,K1- Knee angle in phase I,K2- Knee angle in phase II,K3- Knee angle in phase III,H1- Hip angle in phase I,H2- Hip angle in phase II,H3- Hip angle in phase III

in the spastic antagonistic muscles but to abnormalities of agonist contraction.[16]

There was a strong positive significant correlation between plantar flexion range of motion and total time duration of sit to stand on the contrary there is a strong negative significant correlation between dorsiflexion range of motion and total time duration of sit to stand which suggests that with more the time subject takes for sit to stand lesser is the dorsiflexion range of motion and more is the plantar flexion range of motion. It may be explained by the above result that more the plantarflexor spasticity more time it will take to complete the sit to stand movement as with more plantarflexor spasticity more restricted dorsiflexion range of motion. Lomaglio *et al* in a study reported that ankle dorsiflexion and knee extension moments on the paretic side as well as the degree of weight-bearing asymmetry significantly correlate to a prolonged duration of self-paced sit to stand.[4] And it can also be explained as of hemiparetic muscle weakness, the subjects with stroke may not be able to generate sufficient forces for propelling the body forward and upward. The subjects with stroke may also have problems with coordination of centre of mass horizontal and vertical momentum during rising to walk.[2]

There was a weak non-significant correlation between plantar flexion range of motion and ankle kinematics of sit to stand. Similarly there is a weak non-significant correlation between dorsiflexion range of motion and ankle kinematics of sit to stand suggested that there is no effect of ankle joint range of motion on ankle kinematics of sit to stand. This is in accordance with study done by Kluding *et al* who reported that an increase in ankle range of motion did not improve ankle joint kinematics.[5]

The result showed that there was no correlation between plantarflexion range of motion and knee kinematics in phase I and phase II and has moderate significant negative correlation in phase III of sit to stand. Similarly there is very weak non-significant positive correlation between dorsiflexion range of motion and knee kinematics in phase I and phase II and has moderate significant positive correlation in phase III of sit to stand. Significant result occurred between ankle joint range of motion (plantarflexion and dorsiflexion) and knee kinematics in phase III of sit to stand as phase duration of phase III is more (mean=1.92 s) among three phases of sit to stand. According to Margaret K.Y. Mak *et al*[17], during the kinematics of sit to stand movement, the initial period (initiation phase) involves dorsiflexion of the ankle joint (as center of pressure of the foot ground force moved posterior towards the heel) and flexion at the hip joint which usually increases from 80 degree to 120 degree, at the instant of seat off (forward acceleration phase). The knee joint angle remained constant during the forward acceleration phase, and reached its peak torque very close to the instant of seat off and then started to extend at seat-off until full extension at the end of the rising phase. Afterward, the extension torques at the hip and the knee joints started to descend, while the ankle torque reversed direction as the centre of pressure of the foot-ground forces moved anteriorly to the ankle joint at the end of the movement. From the above discussion of kinematics it can be seen that during phase I and II there is little involvement of knee and ankle together but in phase III (rising phase) we see that there is involvement of knee and ankle together that is when a knee go for extension the ankle torque reverse the direction (that is towards plantar flexion) as the centre of pressure of the foot ground force moved anterioly to the ankle joint at the end of the movement.[17]

The result showed that there is no correlation between plantarflexion range of motion and hip kinematics in phase I and phase II and has moderate significant negative correlation in phase III of sit to stand. Similarly, there is very weak non-significant correlation between dorsiflexion range of motion and hip kinematics in phase I and phase II and has moderate significant positive correlation in phase III of sit to stand. This difference in significance level occur may be because the phase duration of phase III is

more (mean=1.92) when compared to phase I (mean=0.91) and II (mean=0.71) respectively. And it was explained by Kluding *et al* who showed that the kinematics in proximal joints compensate for the deficits in the distal limb and proximal kinematics may have affected the amount of dorsiflexion measured during sit to stand and gait.[5]

For the purpose of analyzing sit to stand movement, we followed study done by Schenkman *et al*.[15] as sit to stand movement was divided into four phases (flexion momentum, momentum transfer and extension phase) in the present study. A fourth phase (stabilization phase) has not been analyzed because it is difficult to ascertain as there is no easy method of reliably identifying the transition between the postural movements resulting from rising and normal postural sway. A two-dimensional analysis was considered adequate since it has been demonstrated that sit to stand is primarily a sagittal plane activity in healthy subjects.[18] The subjects were instructed to keep their arms folded in across the chest in order to prevent the use of the upper extremities while executing sit to stand as in accordance with Janssen *et al* and prevent asymmetrical weight bearing, and the position was also adopted to avoid obstructing the camera's view of the markers.[18] Etnyre *et al* have reported that arms could contribute asymmetrical forces more readily, as with the arms free and hands on arm rests conditions.[19] In the present study, performance of sit to stand transfer has been standardized for starting position (hip, knee and ankle angle at 90 degrees position) and speed of movement to acquire a more or less universal movement pattern.[20] Subjects were asked to rise from the bench during sit to stand movement at their normal pace in accordance with Chou *et al* who reported that from sit to stand, the maximum oscillation in the anteroposterior direction was significantly greater at fast speeds than natural speeds, suggesting that the faster movement had greater instability during sit to stand transfer.[21]

To establish the reliability of the motion analysis tool, 2 raters, tested the repeatability of ankle kinematics and total time duration measure during sit to stand, on a group of 18 normal subjects. Inter-rater intra-class correlation coefficient (ICC) was found to be 0.99 for ankle kinematics and 0.99 for total time duration of sit to stand movement whereas, intra-rater intra-class correlation coefficient (ICC) was found to be 0.98 for ankle kinematics and 0.99 for total time duration of sits to stand movement. This indicates high consistency on repeated analysis.[22,23]

The results of the study support a rehabilitation program which focuses on ankle plantarflexion, dorsiflexion range of motion and spasticity to improve sit to stand preferably with a control intervention in stroke patients. It has also been reported that those with prolonged sit to stand movement duration experience more falls therefore proper intervention strategies to sit to stand training may be developed and implemented.

Future studies can focus on understanding the other impairments affecting sit to stand movement. The missing components identified during the task can be trained and effect of continual practice of these components can be analyzed. The limitations of the study were small number of sample, all the other variables affecting the sit to stand such as stage of recovery ,strength of lower limb musculature was not controlled.

Conclusion

Plantarflexor spasticity and ankle joint range of motion is significantly correlated with total time duration of sit to stand movement and ankle joint range of motion also has a significant correlation with sit to stand kinematics in phase III of knee and hip. The ankle impairments like plantarflexor spasticity and reduced ankle joint range of motion can affect sit to stand movement, so such impairments should be addressed during various therapeutic interventions.

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Original Article

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Effect of Low Dye Calcaneal Taping on Angle of Pelvic Tilt in Individuals with Excessive Calcaneal Eversion

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Abstract

Background: The pelvic girdle forms a closed kinematic chain with upper and lower quadrants of human musculoskeletal system of which the foot is an integral component. Individuals with excessive calcaneal pronation are susceptible to low back pain due to an exaggerated lumbar lordosis that can result from an internal rotation of tibia & femur. In order to treat this low back pain it becomes essential to correct foot posture .Literature shows the efficacy of low dye calcaneal taping in the correction of excessive calcaneal eversion. There is however scarce evidence available regarding this effect on angle of pelvic tilt & thereby on low back. Hence this study is undertaken.

Objectives: To compare the angles of pelvic tilt in individuals with excessive calcaneal pronation before and after Low dye calcaneal taping. ***Methodology:*** Angle of pelvic tilt of 30 females with a calcaneal eversion of more than 6 degrees was measured prior to the application of tape. Low dye calcaneal taping was then applied following which the angle of pelvic tilt was were measured again.

Data Analysis: Paired t-test was used to compare the mean values of pelvic tilt angle pre and post taping.

Results: Significant change in mean pelvic tilt angle was found pre and post calcaneal taping. ***Conclusion:*** Immediate change in the angle of pelvic tilt can be obtained by correction of excessive calcaneal eversion with Low dye calcaneal taping.

Key words: Low back pain; Pelvic tilt; Pronation of foot.

Introduction

The pelvic girdle forms a closed kinematic chain with upper and lower quadrants of human musculoskeletal system of which the foot is an integral component.[1] The subtalar joint being an integral component of the foot compensates to changes in the upper and lower quadrants through excessive calcaneal supination or pronation.[2] According to biomechanical principles, an increase in the calcaneal pronationby a degree can lead to an increase in the internal rotation of the tibia and femur. Thisinternal rotation of tibia and femur results in tension of the iliopsoas muscle causing an increase in the pelvic anteversion torque. Excessive internal rotation of the femur also leads to the posterior location of the femoral head causing an increase in anterior tilt of the pelvis.[3,4,5,6] All the above mentioned factors can exaggerate the lumbar lordosis and make an individual susceptible to back pain.[7] Sam Khamis *et al* conducted a study on normal individuals and assessed the angle of pelvic tilt by inducing hyperpronation in the foot. They concluded that hyperpronation of the foot causes an increase in internal rotation of the tibia which in turn causes increase in internal rotation of the femur thus causing increase in angle of anterior pelvic tilt.[8] Levine D and Whittle MW conducted a study on normal individuals and concluded that there is significant change in lumbar lordosis when there is a change in

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angle of pelvic tilt.[9]

As calcaneal eversion can be a source of back pain it is necessary to decide on the method of intervention which helps in controlling the excessive calcaneal eversion during weight bearing.[10]

Various methods have been incorporated for correcting the excessive calcaneal eversion which includes foot orthoses and therapeutic taping. Therapeutic taping of the foot has been shown to realign the calcaneum in neutral position while supporting the medial arch.[11-15] The most common method used in antipronation taping is Low-Dye calcaneal taping. The technique includes calcaneal slings and reverses sixes which helps in controlling the calcaneal eversion in weight bearing. In addition, to positioning the calcaneum in neutral position, taping also increases the proprioception of the foot.[10] B.Vincezino *et al* investigated the effect of low dye calcaneal taping versus orthosis for correction of hyperpronation of foot and found low dye calcaneal taping to be effective.[16]

The above literature showed the relation between excessive calcaneal eversion and angle of pelvic tilt, and the efficacy of calcaneal taping in the correction of calcaneal eversion. There is however scarce literature regarding the change in the angle of pelvic tilt through correction of excessive calcaneal eversion, hence the study is undertaken.

Hypothesis

Research Hypothesis

Low dye calcaneal taping reduces the angle of anterior pelvic tilt in individuals with excessive calcaneal eversion

Null Hypothesis

Low dye calcaneal taping does not reduce the angle of anterior pelvic tilt in individuals with excessive calcaneal eversion

Objectives of the study

a) To measure the angle of pelvic tilt in individuals with excessive calcaneal eversion before and after low dye calcaneal taping.
b) To compare the angles of pelvic tilt in individuals with excessive calcaneal eversion before and after taping.

Methodology

Inclusion criteria

1. Asymptomatic individuals with calcaneal eversion > 6.[7]
2. Males and females aged between 18-30 yrs.

Exclusion criteria

1. History of lower limb injuries
2. Lower limb deformities / spinal deformities
3. Neurological deficits in the lower limbs
4. Limb length discrepancies
5. History of low back pain.

Materials

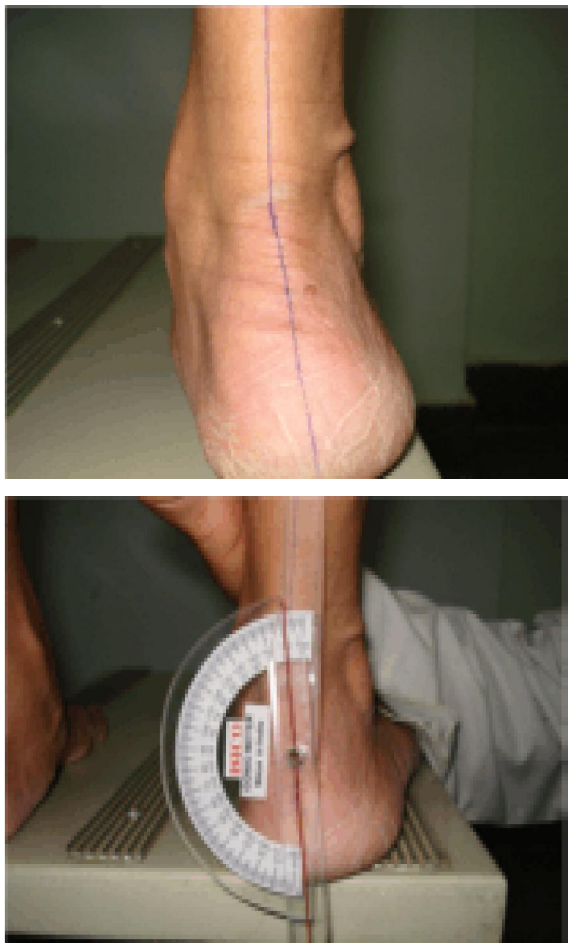
1. SP 2 - Rigid Adhesive Tape of 1and1/2 inches width
2. Milk of magnesia
3. Scissors
4. Goniometer
5. Fluid Level
6. 100 cm scale
7. Calipers
8. Marker Pen
9. Half meter scale

Procedure:

An ethical clearance was obtained from the ethical committee of M.S.Ramaiah Medical College. Both males and females of M.S.Ramaiah Medical College and Nursing college were screened by the researcher for the eligibility of the study. 30 female participants from M.S. Ramaiah Medical and Nursing College who fulfilled the inclusion criteria andexclusion were taken for the study through purposive sampling. A control group was not taken as it was a pre and post design. An informed consent was obtained from the subjects prior to the study (Annexure 1).

A brief assessment of the subjects which included the demographic data was taken prior to the initiation of the study. The Calcaneal eversion and angle of pelvic tilt of each subject was then measured prior to the application of the tape.

Figure 1 & 2: Measurement of calcaneal eversion



Measurement of calcaneal eversion: In prone lying position a line was drawn to bisect the gastronemius and calcaneum. The individual was then made to stand on a stepper in bilateral stance. The angle formed between the line bisecting the gastronemius and the line bisecting the calcaneum was measured using goniometer. (Figure 1 and 2)

Measurement of Pelvic tilt: To measure the pelvic tilt an instrument was constructed for the study. The instrument was devised to measure the distance from Posterior Superior Iliac (PSIS) and Anterior Superior Iliac Spine (ASIS) to ground and the distance between ASIS and PSIS. To measure the distance from ASIS and PSIS to ground a 100 cm scale, half meter scale and a fluid level was used. The 100 cm scale was placed vertically, half a meter scale was placed perpendicular to the vertical scale and fluid level was placed on the horizontal scale to check the alignment of the scale placed horizontally. To measure the distance between the ASIS and PSIS a scale of 24 cms and two long wooden rods were used. One rod was fixed at the PSIS and the other movable rod was kept at the ASIS. The device was calibrated and the inter and intra rater reliability that was assessed prior to the commencement of the study. Pearson's correlation coefficient was used to assess the inter rater and intra rater reliability. The inter rater reliability was 0.95 ($p<0.05$) and was measured at an interval of 2 days. The intra rater reliability was 0.9 ($p<0.05$) and was assessed by two Physical therapists. The subjects were then asked to stand with feet apart. The PSIS and ASIS were marked by a marker pen. The distance from PSIS and ASIS to ground and the distance between ASIS and PSIS was then measured (Figure 3, 4 and 5).[17]

Three measurements of angle of pelvic tilt were taken and the average of three was selected for the analysis. Pelvic tilt angle was then calculated using a trigonometric equation

$$\text{Sin theta} = \frac{A - B}{C}$$

Figure 3: Measurement of ASIS to Ground

Figure 4: Measurement of PSIS to Ground

Figure 5: Measurement of distance between ASIS and PSIS

Figure 6: Low Dye Calcaneal Taping with mini stirrups, calcaneal slings & reverse sixes

Where, A - Distance from PSIS to ground

B – Distance from ASIS to ground

C - Distance between ASIS and PSIS

Following the pre measurement of calcaneal eversion and angle of pelvic tilt the subjects' foot was taped in long sitting position. The taping technique used is mentioned below:

Taping Technique: The subject was seated in long sitting position with the lower one third of the leg out of the couch. The ankle and foot were maintained in neutral position. A strip of tape was applied over the first metatarsal along the medial side of the foot; a longitudinal traction was applied and then placed on the lateral side on the fifth metatarsal. Mini stirrups were applied from lateral to medial direction until the calcaneum was covered with traction applied medially to oppose pronation. A locking anchor was applied. An anchor was applied at the junction between the upper two-third and lower one-third of the leg. Calcaneal sling began from the anterior center part of the anchor, coursed distally in an oblique orientation towards medial malleolus, passed beneath the calcaneum and continued laterally and posterior to the

calcaneum. Traction was given to maintain the calcaneum in inversion and inserted at its origin. Reverse sixes were applied beginning from the medial malleolus, passed over the dorsum of the foot and beneath the midfoot, a traction was given at this point in an upward direction to gain inversion of the midfoot and inserted at the anterior aspect of the anchor over the leg. Three such reverse sixes were applied. A closing anchor was then given at the end of the taping. (Figure 6).[18]

The subjects were again asked to stand with the tape on and feet apart. The angle of pelvic tilt was reassessed with the instrument constructed for the study. Three readings were taken and the average of three was selected for the analysis.

Data Analysis

Statistical Methods

Descriptive statistical analysis has been carried out in the present study. A measurement of angle of pelvic tilt was measured before taping and immediately after taping. The pre and post values were compared and mean value, standard error, confidence interval and effect size was obtained.

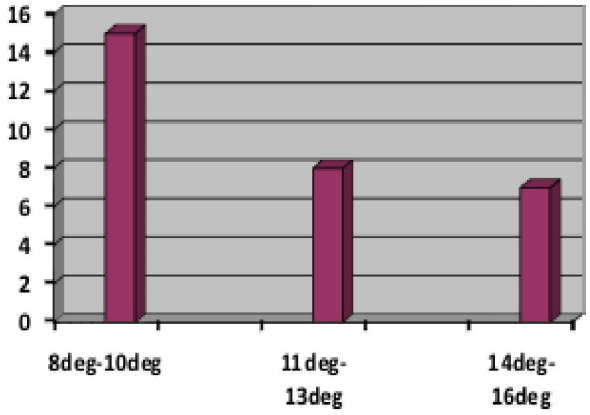
Statistical tests:

Paired t-test was used to compare the degree of pelvic tilt both pre taping and immediately after taping was done. The precision considered was 5% as alpha error and 5% as beta error. The statistical software namely SPSS 15.0 was used for analysis of the data and Microsoft Excel has been used to generate graphs and tables.

Table I: Demographic characteristics

Basic Characteristics	Study Group (Mean)
Number of subjects	30
Age in years	22.4 ± 1.8
Height	158 ± 4.869
Weight	56.9 ± 5.792
Calcaneal eversion	11.333 ± 2.425
Gender	
Males	0
Females	30

Figure 7: Angle of Calcaneal eversion of the subjects



Results

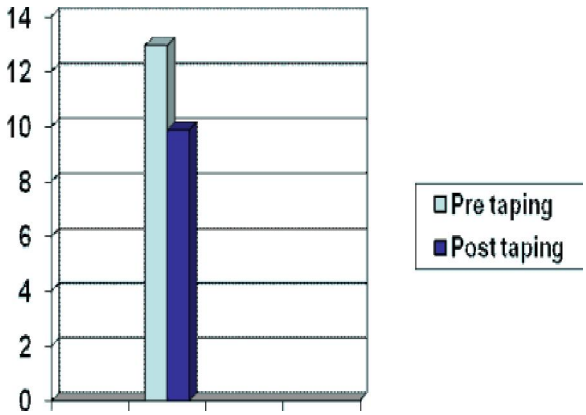
The total number of subjects who volunteered for the study was thirty consisting of only females. Thirty subjects in the age group of 18-30 years were taken for the study. The mean age group of the subjects in the study was 22.4 ± 1.8 years. Males were not

Table II: Comparison of the mean of pelvic tilt angle before and after taping

PELVIC TILT	N	Mean	Std. Deviation	Std.Error Mean
PRE_DEG	30	12.9387	1.96370	0.35852
POST_DEG	30	9.8550	2.09579	0.38264

Comparison Pelvic tilt	t-value	p-value	Effect Size
Pre Taping And post Taping	16.724	p<0.001	1.519

Figure 8: Comparison of the mean of pelvic tilt angle before and after taping



included as none of the males screened through purposive sampling had a calcaneal eversion of more than six degrees. The mean of degrees of calcaneal eversion prior to the application of the tape was 11.333±2.425 degrees. This infers that the maximum of subjects studied presented with calcaneal eversion ranging from 8^0-10^0.

The pre taping and post taping values of pelvic tilt angle were compared using paired t-test. The t-value obtained was 16.724 ($p<0.001$). The result showed that there was significant decrease in the mean of the pelvic tilt angle after taping in comparison with mean of the pelvic tilt angle before taping.

The effect size for mean of pre and post values of pelvic tilt angle was calculated using Cohen's d formula and the value obtained was 1.519. This shows that the effect size obtained in the present study was clinically significant.

The above graph shows that the maximum number of subjects studied presented with calcaneal eversion ranging from 8 degrees to 10 degrees.

Analysis of the angles of pelvic tilt before and after low dye calcaneal taping showed a significant difference in the angle of pelvic tilt between the two groups ($p < 0.001$). It showed that the angle of pelvic tilt reduced significantly post calcaneal taping.

The above graph shows the reduction in the angle of pelvic tilt after the application of low dye calcaneal taping.

Discussion

The present study evaluated the angle of pelvic tilt immediately after low dye calcaneal taping in individuals with excessive calcaneal eversion.

The results of the study showed that the correction of excessive calcaneal eversion by Low dye calcaneal taping helps in immediate reduction of the angle of pelvic tilt in individuals with excessive calcaneal eversion. The effect size showed large size difference which infers that the reduction in angle of pelvic tilt is clinically significant.

The reduction in the angle of pelvic tilt could have probably occurred due to the correction of the position of the calcaneum by the tape. As the calcaneum position was corrected approximately to the neutral position, the plantar condyles of calcaneum was placed on the surface. This would then cause a reduction in the internal rotation of the tibia and femur. This internal rotation of the femur decreases the tension in the iliopsoas muscle thereby causing a pelvic anterversion torque and causing the anterior pelvic tilt. This can be supported by a study a conducted by A Hadley *et al* who found that Low dye calcaneal taping is an effective method in controlling the excessive calcaneal eversion which in turn controls excessive internal rotation of the tibia. The effect produced by the tape was present even after ten minutes of exercise.[19]

Blinding could have been done to assess the angle of pelvic tilt pre and post calcaneal taping. Future studies could be done to assess the long term effects of taping on the angle of pelvic tilt.

Conclusion

In the present study, it was seen that the correction of excessive calcaneal eversion by low dye calcaneal taping causes an immediate reduction in the pelvic tilt angle in individuals with excessive calcaneal eversion.

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Original Article

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Hindi Translation and Evaluation of Psychometric Properties of Functioning Everyday with a Wheelchair (FEW) Tool on Individuals with Spinal Cord Injury: A Pilot Study

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Abstract

Objective: Functioning Everyday with A Wheelchair (FEW) Tool is a self-report questionnaire to be administered over time to consumers of wheeled mobility and seating technology, as a dynamic indicator or profile of perceived user function related to wheelchair use. The aim of this study was to translate this tool into Hindi language, so as to make it available for use in a population who don't understand English; and to test its content validity and internal consistency in Spinal Cord Injury population.

Methods: The FEW tool was translated into Hindi and made ready for application by a translation committee. The tool was then reviewed by a review committee to check the translations. Then, pilot testing was done, where subject responses and comments were noted. A sample of 15 subjects was recruited for pilot testing. Lastly, the content validity for the tool was determined by a panel of 10 subject matter experts (SMEs).

Results: The CVR for each individual item on the scale was found to have a significant value at $p<0.05$. The overall content validity of the scale was determined by the CVI (0.89), which was significant. The Internal Consistency Reliability of the tool, calculated at the time of pilot testing was found to have a significant value for the Cronbach's alpha (0.87).

Conclusion: The Hindi translated version of the FEW tool holds content validity and internal consistency for use in subjects using wheelchairs with spinal cord injury.

Keywords: Spinal cord injury; Content validity; Internal consistency reliability; Functioning Everyday with a Wheelchair; Cross cultural adaptation; Environment.

Introduction

The wheelchair is among one of the most important devices used in rehabilitation for mobility. Wheelchairs are used to enhance function, to improve independence, and to enable a person to successfully live at home and in the community. On the other hand, a wheelchair may be perceived as negatively impacting a person's life if it does not enable him/her to participate fully in social and community activities.[1]

People with spinal cord injury rely on assistive technology, especially their wheelchair, to perform in many of life's activities.[1] Seating and mobility are important considerations for individuals with Spinal Cord Injuries, because the seated position forms the foundation from which they perform the essential activities of daily living, including tasks involving mobility.[2] Approximately 82% of persons with spinal cord injury are dependent on wheelchair for mobility. For many patients with spinal cord injury, a wheelchair is the primary means of locomotion.[3,4]

Little empirical work has been done to assess the effects of wheelchair interventions on consumers. Most literature on wheelchairs is focused around issues of design, consumer

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preferences, use, disuse, abandonment, cost, and policy. What is not known is how wheelchairs and related factors of a physical disability affect overall participation. Hence, the user's assessment of daily participation as well as wheelchair provision needs to be considered to identify gaps in activity involvement by people with SCI.[1] Emphasis on collecting data from a patient's perspective parallels a shift in theoretical premises in the field of rehabilitative technology, from a medical assessment model to a client-centered perspective. The value of subjective assessments has increasingly been recognized along with the growing awareness of the need for client-centered interventions.[5]

There are a variety of instruments available regarding wheelchair functioning such as Seating Identification Tool (SIT),[6,7] Wheelchair Outcome Measure (WhOM),[7,8] Wheelchair Physical Functional Performance (WPFP),[7,9] Wheelchair User's Functional Assessment (WUFA)[7,9] etc. However, the available instruments do not provide valuable information regarding consumer's self-perceived function with their seating-mobility device. The Functioning Everyday with a Wheelchair (FEW) tool was designed for use by researchers and practitioners to quantify consumer perceived function related to seating-mobility technology.[7]

With a population of one billion and the national language being Hindi, a majority of people speak Hindi in India. Apart from India, there are large numbers of Indians who are settled in various parts of the world and have Hindi as their mother tongue. There isn't any scale available, which deals with the seating and mobility issues for patients of Spinal Cord Injury in the Indian scenario. The FEW is a self administered tool which can be used in India and it can be easier to administer if it is translated into Hindi.

The advantages of translation are that, the translation and adaptation of an instrument is usually less demanding. The cross-cultural differences are dealt with, in the translation process to suit the target population in a different language. The instrument may also be used for comparison of results between countries.[10] Therefore, the aim of this study was to develop FEW into the Hindi language for availability to a large Hindi speaking population of India and to obtain a conceptual equivalence between the original and translated versions which then allows comparison amongst various international trials.

Methods

A convenience sample of 15 wheelchair users with Spinal Cord Injury was recruited from Indian Spinal Injuries Center, New Delhi. Subjects who met the following criteria such as age 18 years or older,[7] using manual/ power wheelchair for at least 2 weeks,[11] patients who are native speakers of Hindi Language, patients with a primary level of education and adequate cognitive status on assessment were included in the study. Subjects with medical conditions which could hamper the use of a wheelchair were excluded from the study. The study was approved by research and ethics committee of ISIC Institute of Rehabilitation Sciences, New Delhi.

The translation of the FEW into Hindi was done by the EORTC manual guidelines.[12] The EORTC manual is an accepted and widely used procedure for translations. The FEW tool was translated into Hindi by a Translation Committee, which comprised of five translators working for the Hindi Section, Government of India. Translator 1 and 2 translated the tool into Hindi, translators 3 and 4 back-translated the tool into English. Translator 5 was the coordinator for the whole process, and was involved in both. The forward translation and back translation processes. The scale was then reviewed by a translation Review Committee, which comprised of 2 senior physiotherapists, 2 senior occupational therapists, and 2 peer counselors. The comments and suggestions of the Review Committee were then sent back to the : Translation Committee for corrections in the next intermediate Hindi version of the

scale. After repeating this process thrice, the final translated copy was then ready to be sent for pilot testing.

In the pilot testing phase, the Hindi translated version of the FEW tool was administered to a sample of 15 spinal cord injury patients. The scores of the administered tool were retained for calculating the internal consistency of the tool. Apart from this, an interview was conducted to find out the problems with the Hindi translated version of the FEW tool. The suggestions were incorporated in the final translated Hindi version of the FEW tool and the scale was sent for content validity.

The scale was reviewed by the rehabilitation professionals to determine the face validity. Content validity was determined by calculating the Content Validity Ratio (CVR).[13] It determined, if the skill or knowledge measured by this item was:

- Essential (score = 1)
- Useful, but not essential (score = 0)
- Not necessary (score = -1)

The Quantification was done according to the formula:

Where n_e is the number of subject matter experts (SME) indicating 'essential' and N is

$$CVR = \frac{n_e - N/2}{N2}$$

the total number of SMEs. Responses for all items were pooled and the number indicating 'essential' for each item was determined. The CVR is an item statistic that is useful in the rejection or retention of specific items. After the items had been identified for inclusion in the final form, the Content Validity Index (CVI) was simply calculated as the mean of the CVR values of the retained items.

Internal Consistency Reliability was determined by calculating the Cronbach's Alpha by the formula[14]

k = number of separately scored test items

$$Coefficient\ \alpha = \frac{k}{k-1}\left[1 - \frac{\sum s_i^2}{s_t^2}\right]$$

$\sum s_i^2$ = sum of the item variances for all test items

s_t^2 = variance of the total test scores

Data Analysis

Statistical Package for Social Sciences (SPSS) for Windows version 16 was used for the data analysis. Mean age of participants was calculated using descriptive analysis. Content Validity was calculated using the Content Validity Ratio formula. Content Validity Index was calculated by taking out a mean of the values of the individual CVRs of each item. Reliability analysis was done for internal consistency of the Functioning Everyday with a Wheelchair (FEW) Hindi version by calculating the Cronbach's Alpha value.

Results

The demographic details of the subjects (n=15) who participated in the study is tabulated in Table 1. The mean (S.D.) of individual items of Hindi translated version of the FEW Tool is tabulated in Table 2 to

Table 1: Demographic Details of the Sample (N=15)

Variables		N = 15
Age (in yrs.) (Mean ± SD)		27.53 ± 6.79
Time since injury (in months) (Mean ± SD)		8.87 ± 8.51
Time since same wheel chair (in months) (Mean ± SD)		4.73 ± 5.10
Gender (Male/ Female)		13/ 2
Type of wheel chair	Active	2
	Semi Active	6
	Passive	7
Type of Injury	Quadriplegia	4
	Paraplegia	11

Table 2: Mean and S.D. of Individual Items of Hindi Translated Version of FEW Tool

S. No.	Item Number (N)	Mean ± S.D.
1	1	3.93 ± 1.71
2	2	4.27 ± 1.22
3	3	4.33 ± 1.50
4	4	3.73 ± 1.53
5	5	2.73 ± 1.94
6	6	3.47 ± 1.84
7	7	2.53 ± 2.29
8	8	4.47 ± 1.64
9	9	3.27 ± 2.05
10	10	1.93 ± 1.79

Table 3: Content validity for the Hindi translated version of the FEW tool

S. N.	Item Number (N)	CVR
1	1	.99*
2	2	.99*
3	3	.80*
4	4	.80*
5	5	.80*
6	6	.99*
7	7	.99*
8	8	.99*
9	9	.80*
10	10	.80*
11	CVI	.89*

determine Internal Consistency Reliability. The mean score of the ten items on the tool was 3.67 with a S.D. of ±12.09 (Table 2).

The Content Validity Ratio (CVR) at $p<0.05$, for each item of Hindi translated version of the FEW Tool is given in Table 3. CVI was calculated as a mean of the CVR values of the 10 items of the tool. The content Validity Index (CVI for the tool was found to be 0.89 (Table 3). The value of Cronbach's alpha for the Hindi translated version of the FEW tool was found to be 0.87 (internal consistency reliability).

Discussion

The Functioning Everyday with a Wheelchair (FEW) tool measures functional performance of seating-mobility users at a single point in time and, if administered repeatedly, over a period of time. Utilization of the FEW instrument throughout the service delivery of seating-mobility technology may facilitate practitioner-client interaction by promoting discussion of consumers' current and future skills, goals, preferences, and environmental contexts.

Translation Process

Stage I

Step 1: Forward Translation

The aim of this first step was to translate the FEW into Hindi and produce a version that would be conceptually as close as possible to the original questionnaire, using culturally and clinically appropriate expressions. The English questionnaire was given to two translators. Translator 1 was an English-Hindi-English translator working for the Hindi Section, Govt. of India. He has 24 years experience in the field of translations. Translator 2 was an English-Hindi-English translator working for the Hindi Section, GOI. He has 5 years experience in the field of translations. Translator 5 was the moderator for the entire process. He has 21 years experience in the field of translations. All three translators have Hindi as their native language and have a very good command over English. The first two translators independently translated the FEW. The linguistic register of the questionnaire was equated to that of a person of 12-14 years of age, which led to excluding, as far as possible, technical terms or over sophisticated, pedantic or formal words or phrases. Wherever there were discrepancies between the two, the points were personally discussed between the translators and moderator of the translation committee.

In stage I during forward translation some of the items with discrepancies were as follows. For the title, translator 1 put the heading as 'व्हील चेयर उपकरण'(wheelchair upkaran), which means 'wheelchair tool', whereas it originally is Functioning Everyday with the Wheelchair tool. Translator 2 put the heading correctly, but the word रोज़मर्रा (roz-marah) was difficult to understand according to the prescribed linguistic register. Agreement could not be reached and thus, the moderator used the word हर रोज़ in its place, giving alternating wording to be resolved in back translation. For the phrase 'Directions to Client', the word 'directions' was translated as निर्देश (nirdesh) by translator 1 and हिदायतें (hidayatein) by translator 2. Agreement was reached to use the word निर्देश (nirdesh), as it is the closest translation for the word direction. The sentence formation for the directions was followed as per the translation of translator 1, as it was simpler and easier to perceive and it also matched with the sentence formation of the original English version. Options were seen with the words यदि (yadi) by translator 1 and अगर (agar) by translator 2. The version

by translator 2 was used as it was more frequently used in spoken language and easily understood by the patient. Similarly for the scores provided in the beginning, words such as पूर्णतः सहमत (purnateh sehmat) by translator 2 were not used. Instead पूरी तरह से सहमत (puri tarah se sehamat) would be easily understood and was thus used for the intermediate version. For item 1, the sentence formation of translator 2 was accepted by the translators and the moderator, as its language matched best with the original version. For item 2, the language of translator 2 was taken, but the word मेल खाती हू (mel khati hai) was used instead of अनुरूप है (anuroop hai) for its ease of understanding.

Item 3-5 had words उपयुक्तता (upyukta-ta) and फिट (fit). Both were used for the word 'fit'. The word फिट (fit) by translator 1 was accepted for the problem to be resolved in back translation. The rest of the language was kept the same as used by translator 2. Item 6 has the word 'transfer', which is an activity. It is a noun for which no suitable Hindi word could be found. Thus the word 'transfer' was retained in the Hindi version, as it has a clinical significance for the target population. In item 7, the word निजी (niji) was used by Translator 1, and स्वयं (swayam) was used by translator 2. The word स्वयं (swayam) is difficult to understand in spoken Hindi and hence, the version by translator 1 was taken. For the rest of the sentence formation, translator 2's wording was accepted. For items 8-10, language for sentence formation and ease of understanding was taken by translator 2. The word उपयुक्तता (upyukta-ta) was replaced by फिट (fit).

By the above process, an intermediate Hindi version was prepared with the agreement of the two translators on all the items and minor additions by the moderator. The intermediate version was then ready to go for back translation.

Step 2: Back Translation

Two independent translators, who were unfamiliar with the original English version, back translated the intermediate Hindi version into English. Translator 3 was an English-Hindi-English translator working for the Hindi Section, Govt.of India. He has 24 years experience in the field of translations. Translator 4 was an English-Hindi-English translator working for the Hindi Section, GOI. The two translators independently back-translated the intermediate Hindi version of the FEW into English; without any reference to the original English version.

The problems encountered in the back-translations were as follows. The voice of item 1 is passive in both the versions, whereas that of the original version is active. Translator 3 translated the word कुशलता (kushalta) as 'skillfully', while translator 4 translated it as 'efficiently'. In item 4, the word 'operate' was back translated as 'handle'. In item 5, the words 'different surface heights' was back-translated as 'elevated and depressed surfaces'. The words 'it's functioning' were used instead of the wheelchair. The word indoor was translated as 'घर के अंदर (ghar ke andar) and outdoor was translated as घर के बाहर (ghar ke bahar), which when back translated, came out as 'premises'.

The translated and back translated versions along with the original English version were presented in front of a multi-disciplinary committee, which comprised of 2 physiotherapists, 2 occupational therapists, 2 peer counselors and a rehabilitation psychologist. They reviewed the tool and suggested the remedial steps to be taken for further translations of the scale into Hindi.

The committee found the word मज़बूती (mazbooti) to not match with the English version. मज़बूती (mazbooti) meant 'strength', whereas the word in the original version was 'stability'. In item 4, the word 'operate' was written as चला पा रहा हू (chala pa raha hu), and back translated as 'handle', thus, the

committee members suggested that the wording for the phrase should be changed. Also, in items 4 through 10, the end phrase was कर पा रहा हू (kar pa raha hu), which meant 'I am able to do' and not 'allows me'. Hence the committee members suggested that rephrasing of the language should be done. Another change suggested by one committee member was for the word 'indoors', which was translated as घर (ghar). Changes were made so that, the word included a broader meaning and included indoor places apart from the patient's house.

Stage II

Step 1: Forward Translation

In the second stage of the translation process, the word 'शरीर' (shareer) was replaced by 'आसन' (aasan), as it best matches the word posture when back translated into English. The voice of the question was changed to match the active voice of the original version. The word घर (ghar) was changed to the word 'परिसर' (parisar). This was done, as the word घर (ghar) was limiting the patient's ability to roam around only with respect to the home. The word 'परिसर' (parisar) was used instead. The phrase 'कर पा रहा हू' (kar pa raha hu) was rephrased as 'कर पाने मे सहायक है' (kar pane me sahayak hai). The wording of item number 5 was changed to match the patient's ability to specifically reach on different heights, and carry out the tasks.

Step 2: Back Translation

The word 'आसन' (aasan) back translated as posture, matching the original wording. The word 'परिसर' (parisar), although back translated as complex/ compound, but best matched the meaning of the question in Hindi, and was found to be better suited than the word घर (ghar) by the expert panel. The phrase 'कर पाने मे सहायक है' (kar pane me sahayak hai), back translated as "helps me to', which was found not to match with the original version, which said 'allows me to'.

The back translation of the item no. 5 did not come out similar to the original version. The original version stated that 'the ability to reach and carry out' was together. But in the back translated version, the words 'reach' and 'carry out' were coming out separately and were found to change the meaning of the questionnaire. The word 'चलायमान' (chalaymaan) when back translated meant 'mobile or movable', and not 'mobility'.

The committee recommended the following changes at this stage. Firstly, they accepted the word 'परिसर' (parisar), as it better matched the ability to explain the meaning of the word 'indoors' in the original version. Secondly, they suggested changes for the phrase 'कर पाने मे सहायक है' (kar pane me sahayak hai), because it did not mean 'allows me to', as in the original version. Thirdly, they suggested changes in the phrasing for item number 5, because the two items 'reach' and 'carry out' were coming out as separate items in the Hindi translated version and not as a single unit as in the original version. Lastly, they suggested that the word 'चलायमान' (chalaymaan) be changed, as it back translated as 'movable', and not 'mobility'.

The changes suggested by the committee members were then incorporated into the next stage of the translation process, to form the third intermediate copy of the scale.

Stage 3

Step 1: Forward Translation

The word 'सहायक' (sahayak) was changed to 'अनुमति' (anumati) to match the original wording. The language of item number 5 was rephrased to suit the questionnaire's original version. The word 'चलायमान' (chalaymaan) was changed to 'गतिशीलता' (gatisheelta). The phrasing of the instructions was done according to the suggestions given by the expert committee.

Step 2: Back translation

The word अनुमति (anumati) back translated as 'allowing', which matched the original version. The back translation of item number

5 matched the original version in its content. The word 'गतिशीलत' (gatisheelta) came out as 'mobility' and the error was corrected.

As the back translated version of the third intermediate Hindi version of the scale came out to match the original English version, and was without any more errors, it was accepted by the translation review committee as the final version. (Appendix 1)

The Hindi version of the tool was administered on 15 spinal cord injury patients for pilot testing, who had been randomly selected on the basis of the inclusion criteria stated in the methodology. After the administration of the scale, a structured interview was administered to the patients to determine whether the wording used made any of the translation items difficult to answer, confusing, difficult to understand, upsetting or offensive and/or, whether the patient would have asked the question in a different way.

The problems encountered during the scale administration were, that some patients found the word स्थिरता (sthirta) (stability) in question number 1 difficult to understand. The word संचालित (sanchalit) (operate) in question number 4 was difficult for most of the patients. Some patients also reported that they could not comprehend the exact meaning of the word 'परिसर' (parisar). The language of question number 1 was confusing for some patients and 1 patient could not understand the meaning of the word रोज़मर्रा (roz-marah). The meaning phrase विभिन्न सतह ऊचाईयाँ (vibhinna satah uchaiyan) was not clear.

On the basis of this interview, the provisional translation required adaptation to incorporate the changes suggested by the pilot population. The tool was then taken back to the translation committee for providing alternating wording. The necessary changes were incorporated and the final version of the scale was thus prepared. The scale was reviewed by rehabilitation professionals and face validity was established. After the translation and pilot testing phase, the scale was ready for the determination of the content validity of the scale. A quantitative review were conducted to determine content validity. During the quantitative review of the tool, none of the items on the scale were rated as 'not essential' by the reviewers. Items 3, 4, 5, 9 and 10 were each rated as 'useful, but not essential' by the reviewers. The content validity ratios indicated good content validity of the scale. The Internal Consistency Reliability of the tool, calculated at the time of pilot testing was found to have a significant value for the Cronbach's alpha.

The development of the Hindi translated version of the FEW would help the physical therapist to measure the perceived user function related to wheelchair use in people with SCI. The development of the scale in Hindi ensures that the common man would be easily able to understand and comprehend the tool. The Hindi translated version of the FEW can also be used to make international comparisons and cross cultural research studies. Clinically, having standardized assessments available in Hindi will assist the clinicians in providing culturally sensitive assessments to clients who do not understand English.

Further studies can be done to determine other psychometric properties of the scale. The Hindi translated version of the FEW tool can be used in clinical practice in the future to check the efficacy of the user perceived function with a wheelchair and to follow up with patients and with different clinical and environmental conditions.

Conclusion

The Hindi translated version of the functioning everyday with a wheelchair (FEW) tool, has been found to have adequate content validity and good internal consistency on spinal cord injury subjects using wheelchairs, so this tool can be used to assess the user perceived functions related to wheelchair use in spinal cord injury subjects.

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Review Article

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Exercise Therapy and Quality of Life in Cancer: An Overview of Systematic Reviews

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Abstract

This article is aimed to provide an evidence-informed integrative overview on exercise therapy and its influence on quality of life in cancer through a literature search of PubMed. Nine systematic reviews and/or meta-analyses (cancer=5; breast cancer=2; lung cancer=1; prostate cancer=1) were found including two Cochrane systematic reviews, unanimously demonstrating unidirectional effectiveness for exercise therapy in improving quality of life in people with cancer. This interaction between exercise and quality of life was mediated by a complex intermingled inter-relationship between biological, psychological and social dimensions of health and disease.

Keywords: Participation restriction; Holistic rehabilitation; Biopsychosocial model; Rehabilitation oncology; Behavioral oncology.

Objective

This article is aimed to provide an evidence-informed integrative overview on exercise therapy and its influence on quality of life (QOL) or health-related QOL (HrQOL) in cancer through a literature search of PubMed.

Findings

Cancer

Courneya and Friedenreich[1] located 24 empirical studies published between 1980 and 1997, and 18 studies had consistently demonstrated that physical exercise had a positive effect on QOL following cancer diagnosis, including physical and functional well-being (e.g. functional capacity, muscular strength, body composition, nausea, fatigue) and psychological and emotional well-being (e.g. personality functioning, mood states, self-esteem, and QOL).

Ferrer *et al*[2] in their meta-analysis found that exercise interventions increased QOL, provided that interventions were targeted more on intense aerobic exercise and addressed women.

Mishra *et al*[3] searched the Cochrane Central Register of Controlled Trials (CENTRAL), PubMed MEDLINE, EMBASE, CINAHL, PsycINFO, PEDRO, LILACS, SIGLE, SportDiscus, OTSeeker, Sociological Abstracts, Web of Science and Scopus, and found 56 trials with 4826 participants randomized to an exercise (n = 2286) or comparison (n = 1985) group. "Exercise interventions (walking with/without cycling, resistance training, or strength training; resistance training; strength training; cycling; yoga; or Qigong) resulted in improvements in: HrQOL from baseline to 12 weeks' follow-up or when comparing difference in follow-up scores at 12 weeks; physical functioning from baseline to 12 weeks' follow-up or 6 months; or when comparing differences in follow-up

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scores at 12 weeks or 6 months; role function from baseline to 12 weeks' follow-up or when comparing differences in follow-up scores at 12 weeks or 6 months; and, in social functioning at 12 weeks' follow-up or when comparing differences in follow-up scores at both 12 weeks and 6 months."

Mishra *et al*[4] searched the Cochrane Central Register of Controlled Trials (CENTRAL), PubMed, MEDLINE, EMBASE, CINAHL, PsycINFO, PEDRO, LILACS, SIGLE, SportDiscus, OTSeeker, and Sociological Abstracts, Web of Science and Scopus, and found 40 trials with 3694 participants and found that exercise might have beneficial effects on HrQOL and certain HrQOL domains including cancer-specific concerns (e.g. breast cancer), body image/self-esteem, emotional well-being, sexuality, sleep disturbance, social functioning, anxiety, fatigue, and pain at varying follow-up periods."

Speed-Andrews and Courneya[5] examined the effects of physical activity (PA) upon quality of life and disease prognosis in cancer survivors focusing upon (a) quality of life during treatments, (b) quality of life during survivorship (after treatments), (c) quality of life during palliative care, and (d) disease prognosis end points. "Compelling clinical trial data indicated that PA can improve quality of life end points during treatment and survivorship."

Breast cancer

Duijts *et al*[6] identified 56 studies in their meta-analysis and found the positive effect of behavioral techniques on fatigue, depression, anxiety and stress. Physical exercise interventions had positive effect on fatigue, depression, body-image and HrQOL.

Bicego *et al*[7] searched MEDLINE, EMBASE, CINAHL, PubMed, and PEDro and found nine relevant randomized controlled trials four of moderate methodological quality and five of high methodological quality. "There was strong evidence that exercise positively influences QOL in women living with breast cancer.

Lung cancer

Granger *et al*[8] did a systematic review of articles through electronic databases MEDLINE, CINAHL, EMBASE, TRIP, Science Direct, PubMed, Cochrane Library, Expanded Academic ASAP, MeditextInformit, PEDRO and DARE. The review identified 16 studies on 13 unique patient groups totalling 675 patients with non-small cell lung cancer (NSCLC). Exercise intervention for patients with NSCLC was found to be safe before and after cancer treatment and was associated with positive benefits on exercise capacity, symptoms and some domains of HrQOL.

Prostate cancer

Keogh and MacLeod[9] in their systematic review identified 12 training studies and gave following findings: "Grade A level evidence was observed for the benefits of exercise in improving muscular endurance, aerobic endurance, and overall quality of life, as well as reducing fatigue in prostate cancer patients. Grade B evidence also suggested that exercise may improve prostate cancer patients' muscle mass, muscular strength, functional performance (walking and sit to stand speed), as well as health-related, social and physical quality of life. These effects appeared greater for group-rather than home-based-exercise, especially if these programs included resistance training."

Summary

Nine systematic reviews and/or meta-analyses (cancer=5; breast cancer=2; lung cancer=1; prostate cancer=1) were found including two Cochrane systematic reviews, unanimously demonstrating unidirectional effectiveness for exercise therapy in improving quality of life in people with cancer. This interaction between exercise and quality of life was mediated by a complex intermingled inter-relationship between biological,

psychological and social dimensions of health and disease.

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Review Article

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Plane vs Incline Plyometrics: A Review

Saurabh Sharma*, Abhishek Shukla, Shalini Sharma*****

Abstract

Inclined plyomertics are performed at anteriorly inclined surface which pre-positions the ankle in dorsiflexion before eccentric phase. Plyometrics performed at various surface like clay, sand, wood, grass, and water training can lead to improvements in vertical jump performance, leg strength muscle power, acceleration, balance, overall agility and bone density especially in younger participants. Plyometrics performed at incline surface improve vertical jump, depth jump, counter movement jump and explosive muscle power of gastrosoleus muscle in comparison with same drills performed on various type of plane surface as muscle is at optimal length tension relation. Effectiveness of incline plyometrics on dynamic balance, speed, agility and quickness, may be a future scope of research study. Various type of drills like squat jump, depth jump, box jump at different inclination angle at different type of surfaces are still to be investigated.

Key words: Incline plyometrics; Balance; Squat jump, Depth jump.

Introduction

Fred Wilt, in (1975) a former US Olympic long-distance runner, coined the term plyometrics.[1] Plyometrics or "plyos" for short, are exercises designed to produce fast and powerful movements. They are used by athletes to better their performance in sports, especially those that involve speed, quickness, explosive power and agility.[2]

Fatouros *et al* (200) report plyometrics exercises as those that are characterized by a rapid deceleration of the body followed almost immediately by a rapid acceleration of the body in the opposite direction.[3] It is this eccentric/concentric contraction pattern which is reported to evoke the elastic properties of the muscle fibres and connective tissue in a way that allows the muscle to store more elastic energy during the deceleration phase and release it during the acceleration period.[3,4,5]

Physiology of plyometrics

The physiological adaptations expressed as changes in muscle fibre composition, associated with goal oriented plyometrics training programs, are reportedly generated through a neuromuscular response referred to as the Stretch-Shortening-Cycle (SSC). [3,4,5,6,7,8,9] The SSC involves the combination of eccentric/concentric muscle action, and is characterized by a rapid eccentric muscle action, followed by an immediate and forceful concentric contraction.[3,6,10] The concept of this rate of change in muscle action lies in the premise that when the muscle is stretched while active a greater force capability is created in the subsequent concentric contraction than what would be created from a static, non-pre stretched position.[10] Moore and Schilling suggest that the generation of force production may be linked to the series elastic components of the muscle, and increased neuromuscular reflex activity.[6] The muscle containing 'series elastic' components (Tendons, Sheath, Sarcolema) can be stretched, and on recoiling after stretching,

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can exert a volume of stored potential energy created and held within the increased number of actin-myosin cross-bridge formations held throughout the eccentrically contracted muscle. It is this mechanical actin-myosin disruption during eccentric muscle contraction, and the onwards reciprocal detachment that produces increases in muscular force, and favourable structural adaptations in muscle tissue.[6]

Shilling and Moore further suggest that as the rate of muscle lengthening increases through increased eccentric loading, a brief storage of extra elastic energy takes place, which can be used during the concentric contraction of the jump increasing mechanical force and power.[6] Fatouros *et al* (2000) found in their research on plyometrics exercise training and vertical jumping performance that part of the positive work (expressed as the force exerted across a distance) created by the stored elastic energy derives from the recoil of the tense elastic elements of the contractile proteins.[3] They further suggest that the increase in efficacy of plyometrics movements and the SSC is due to the fact that the previous muscle stretching decreases the time in which positive work is done during the next shortening.[3] It is this rapid deceleration phase of the eccentric contraction which leads to larger force production, as it is this movement which eccentrically lengthens the muscle.[5] The large amount of potential energy within the stretched muscle that is used to reach peak vertical jump velocity and jump height, and thus an increased ability to generate lateral, change of direction, and explosive movement. It is reported however, that this energy can be lost as heat (expressed as an increase in intramuscular temperature) if the concentric contraction phase of the movement is not initiated immediately.[6] This is a core aspect of effective initiation and execution of the SSC, as it is only effective in increasing force and power output if the movement activating it is produced immediately. This highlights the function of the decreased amortization or coupling time between eccentric and concentric movement.[6] GTOs have a inhibitory role during muscle contraction. GTOs are stimulated to send impulses to spinal cord that relay facilitation to limit muscle force production. It's believed that during plyometrics, GTOs excitatory threshold level is elevated so that more stimulation is necessary to produce a response from GTO, allowing for increased tolerance for additional stretch.[3,4,5,6]

Benefits of plyometrics

According to the American Council on Exercise, research studies have shown that plyometrics training can lead to improvements in vertical jump performance, leg strength muscle power, acceleration, balance, overall agility and bone density especially in younger participants.[11,12,13,14,15,16,17]

Plyometrics can improve dynamic balance-an unrealized benefit

Plyometrics training is an well accepted technique for improving the athletic performance but may also facilitate beneficial adaptations in the sensory motor system that enhance dynamic restraint mechanisms [18,19] and correct faulty jumping or cutting mechanics. Balance and stretching-shortening exercise both have a preliminary requirement of preparatory and reactive muscle activity through feed-forward and feedback motor control system. Continuous use of the stretch reflex pathways can decrease the response time and develop preparatory reactive strategies to unexpected joint loads.[18,19,20] Feed-forward strategies employ muscle preactivation to ''stress shield'' for articular and capsuloligamentous[21] structures and are organized based on previous experience with sport-specific activities.[22] Functional training techniques with repetitive jumping and deceleration activities may create plastic neurologic adaptations to motor programs that improve coordination for both performance and dynamic restraint. The feedback motor control process encompasses a number of reflexive pathways that continuously modify muscle activity to

accommodate unanticipated events.[18,19] Because the lower extremity is subjected to high joint loads and velocities during plyometrics activities, these exercises are ideal for encouraging the reflexive pathways of feedback motor control. Reflex-mediated muscle activity is crucial element in dynamic stability and should complement pre-programmed muscle activity to achieve a functionally stable joint. Stretch-shortening exercises are a necessary component for condition the neuromuscular apparatus to respond more quickly and forcefully, permitting eccentric deceleration then developing explosive concentric contractions.[23] Wilk *et al* suggested that muscular performance gains after plyometrics training are attributed to these neural adaptations, rather than to morphologic changes.[24] For this reason, plyometrics training may enhance neuromuscular function and prevent joint injuries by increasing dynamic stability.[25]

Inclined vs plane plyometrics-established and hypothetical advantages

Established advantages

Concept of plyometrics on inclined surface was given by Kannas *et al*, 2011.[26] Incline plyometrics performed at 15^0 inclined plane is helpful in improving explosive plantar flexion and jumping performance in comparison with plane plyometrics with same drills protocol.[26,27] As triceps surae are at optimal length tension relationship[25,28] and additional elongation of dorsiflexion result in a greater energy return from the tendon.[29]

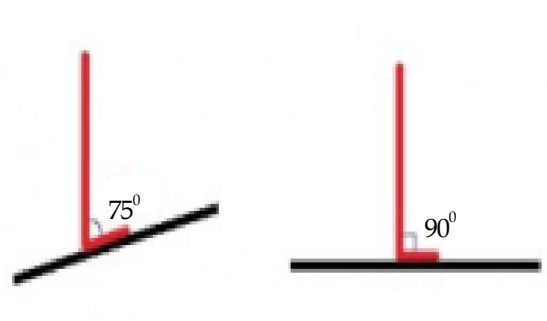
The Acute Response, Kannas *et al* (2011) reported a 10% increase in hopping height when performing the exercise on an inclined surface 15^0.[26]

The Training Response, groups of 10 athletes (all young males but no training history given) performing plyometrics drills on an incline 15^0 or flat surface. Athletes performed 8 sets of 10 consecutive jumps on 4 days a week and for 4 weeks. The incline group was observed to have significant improvements in fast depth jump performance (17% from a 20 cm drop, 14% from 40 cm) with EMG showing increased gastrocnemius activity during the propulsion phase.[27] The incline group showed a tendency for increases in squat, countermovement and slow depth jump performances, these were not significant. Fast depth jumps were described by $<50^0$ of knee flexion, slow depth jumps by $>60^0$ of flexion.

Incline plyometrics has shown better increase in medial gastrosoleus muscle activity [26,27] thus a better eccentric control on abnormal loading.

Hypothesised advantage of inclined plyometrics

- Hypothetically anteriorly incline surface keeps ankle in dorsiflexion and thus in various types of jumping activity less squatting is needed to elicit a stretch shortening cycle for same energy storage, and less lowering of centre of gravity which will allow higher vertical height in concentric phase with same energy stores.
- Muscle activity of ankle plantar flexors is about 35% of total explosive force production in vertical jumping, and to achieve it is squatting is important in order to stretch gastrosoleus muscles, but in this position gastrocnemeus is isolated as being a two joint muscle and primarily Soleus is stretched, which in turn will store less potential energy, incline surfaces may help to stretch these muscles simultaneously for explosive power output in concentric phase of vertical leaps.



- Floor inclination alters kinetic and/or kinematic variables during static standing.[30] When a person is standing on inclined plane body weight tend to produce a posterior ground reaction forces which is equal to = sin β × body weight, (β is angle of inclination of slope) which tend to create a posterior drag on line of gravity of human body. Incline surface thus challenges human body balance much extent in comparison with plane surface. Ankle appears to be the main adapting joint when walking up inclined surfaces creating a roll-over shape that would change in orientation with different levels of inclination.[31] So it is very much clear that ankle proprioceptors will be stimulated for better balance and postural control on inclined surface.

Inclined vs plane plyometrics-established and hypothetical disadvantages

Established side effect of plyometrics is delayed onset muscle soreness (DOMS), which will not be uncommon with inclined plyometrics .The soreness is felt most strongly 24 to 72 hours after the exercise caused by eccentric muscle action.[32] After such exercise, the muscle adapts rapidly to prevent muscle damage, and thereby soreness, if the exercise is repeated.[32,33] Moreover appropriate physical screening, dosimetry modification ,and gradual progression can avoid any type of side effects.[1] Any other side effect of inclined plyometrics is still to be investigated.

Future scope of research in inclined plyometrics

A lot of researches have made a strong foundation that plyometrics can improve explosive strength, speed and agility. Few researchers examined effect of these drills on different type of surfaces like grass, sand, wood and underwater.[11,12] However affect of inclined plyometrics drills on these variables are not examined till yet. There are only a handful of researches which assessed the effects of plyometrics on balance in different sports with clinically insignificant outcomes.[7,11,12,15,34] All the researchers conducted their research on plane surface which was less challenging for overall proprioception and balance mechanism and most of the researches were less biased to ankle dominating plyometrics protocol which are possibly important cause of clinically insignificant results because ankle joint is important for proprioception and postural awareness which often diminishes with various functional ankle instabilities and injury.[35] There is a dearth of research evidence to investigate the effectiveness of incline plyometrics on dynamic balance, speed, agility and quickness, which may be future scope of study. Various type of drills like squat jump, depth jump, box jump at different inclination angle at different type of surfaces are still to be investigated.

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Case Report

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Complete Decongestive Physiotherapy (CDPT) Helps in Management of Post Mastectomy Lymphedema: Case Series Report Part 1

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Abstract:

Lymphedema is defined as the abnormal accumulation of protein rich fluid dysfunction of the lymphatic system, which is a common sequel of cancer therapy. The incidence is highest among patients who have undergone lymph node resection and irradiation.

Various studies had been undertaken to develop less invasive treatments of lymphedema management. Complete decongestive physiotherapy has evolved rapidly over the past decade.

This article is aimed to describe very promising results of CDPT given to patients with diagnosis of post mastectomy lymphedema.

The data represented in this article were retrospectively collected and reviewed. Patients received 15 sessions of CDPT 6 days a week, patients were given extensive patient education during the first consultation about general do's and don'ts, skin care.

Along with resolution of lymphedema, there was good improvement in other symptoms such as pain and paraesthesia. Patients also reported improvement in their psychological well being.

Observation and conclusion drawn from this case series review suggest that inclusion of CDPT in management of post mastectomy lymphedema will not only be useful in resolution lymphedema but also helps in reducing pain, paraesthesia and improving overall quality of life of patients, perhaps more rigorous research and trials with efficient methodology required to establish CDPT as treatment of choice for post mastectomy lymphedema.

Keywords: Lymphedema; CDPT; MLD; Remedial exercises; Pneumatic compression therapy; Compression bandaging; Multi-layer bandaging.

Introduction

Lymphedema, defined as the abnormal accumulation of protein rich fluid due to dysfunction of the lymphatic system, it is a common sequel of cancer therapy. The incidence is highest among patients who have undergone resection and irradiation of a lymph node bed.[1,2]

Lymphedema, developed after mastectomy, which is characterized by edema in the arm and in close parts of the body, close to the arm which could cause cosmetic deformity, physical disorder, loss of function, cellulitis, lymphangitis, and sometimes lymphangiosarcoma. Lymphedema is a chronically, progressive, multifactorial process.[2,3,4]

There are various studies describing risk factors for lymphedema occurrence, being overweight is an important modifiable risk factor for lymphedema. Axillary radiation, surgery that is more extensive, chemotherapy, and active cancer status also were predictive of lymphedema.[5,6]

Lymphedema has both physical and emotional concerns. There is swelling and tightness in the affected arm and at the same

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time, patients complained about reduced flexibility, fatigue, weakness, hopelessness, pain, heaviness, infection, impairment in ability to perform routine daily tasks.[7,8,9]

Lymphedema if not controlled, can result in a lot of complications. The most problematic complications, an increase in repeated infections rate, reduced local immunity in the affected area, serious restraint in mobility which causes to difficulty in daily activities, serious social and emotional problems and changes in the skin.[2,3,4]

Recently, increased attention has been focused on the modification of anti-cancer therapies in an effort to minimize lymphatic compromise. Sentinel lymph node biopsy is an example of a surgical procedure developed to preserve lymphatic function. Concurrent with the development of less invasive treatments, the field of lymphedema management has evolved rapidly over the past decade.[1] Combined manual therapy, often referred to as complete decongestive physiotherapy (CDPT), has emerged as the standard of care. CDPT combines compression bandaging, manual lymphatic drainage (a specialized massage technique), exercise, and skin care with extensive patient education.[10,11]

Methods

Study area and population

This case series study was done retrospectively at BLK super speciality hospital. Various patients with the diagnosis of lymphedema seen at BLK cancer centre being referred for rehabilitation during the year 2011-2013, were reviewed retrospectively. As patients had wide range of different characteristics such as grade of oedema varied from grade 1-2, lower limb and upper limbedema. Some of patients had only radiotherapy and some had lymph node resection as well as radiotherapy. In this case series reports as part 1 we have represented the cases with diagnosis of lymphedema post mastectomy which were more than 80% of cases treated in department of physiotherapy and rehabilitation during above said period.

Picture 1: A lymphedema patient

Patients

Following criteria were considered toinclude cases for this retrospective case series report:

- MRM with axillary lymph node clearance
- Lymphedema Grade-1
- No significant neuropathy sign
- No obesity (at time of intervention, it is being calculated as per WHO criteria, BMI > 30 kg/m2 were considered obese)

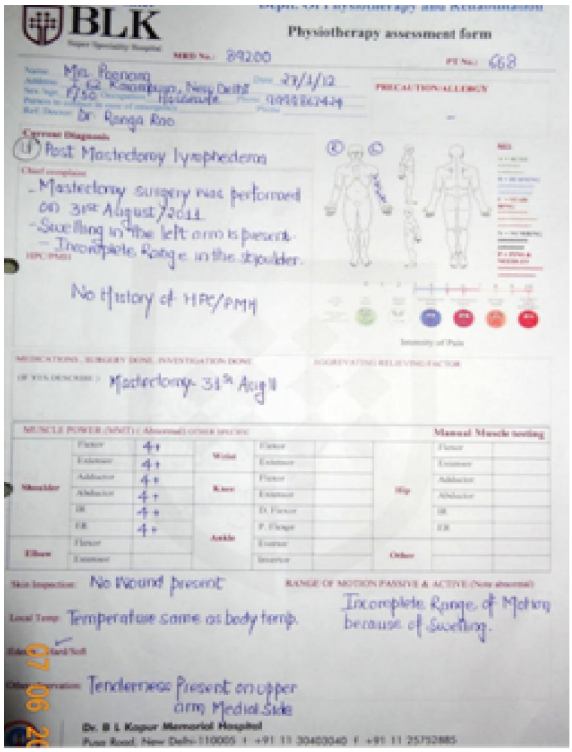
A series of 46 consecutive patients with diagnosis of lymphedema between October 2011 and Feb 2013 being referred to department of physiotherapy & rehabilitation, BLK super speciality hospital. These patients' medical/treatment record were screened. Among these 46 patients 32 patients had diagnosis of upper limb lymphedema, 23 patients were excluded from further data and intervention review because of non-compliance to therapy, uncompleted entire session regimen, obese and associated co-morbidity, those who could not tolerated CDPT (n=4) and based on other criteria as mentioned above. 7 patients irregular during therapy sessions, remaining 4 patients data were critically analysed and are presented in this report.

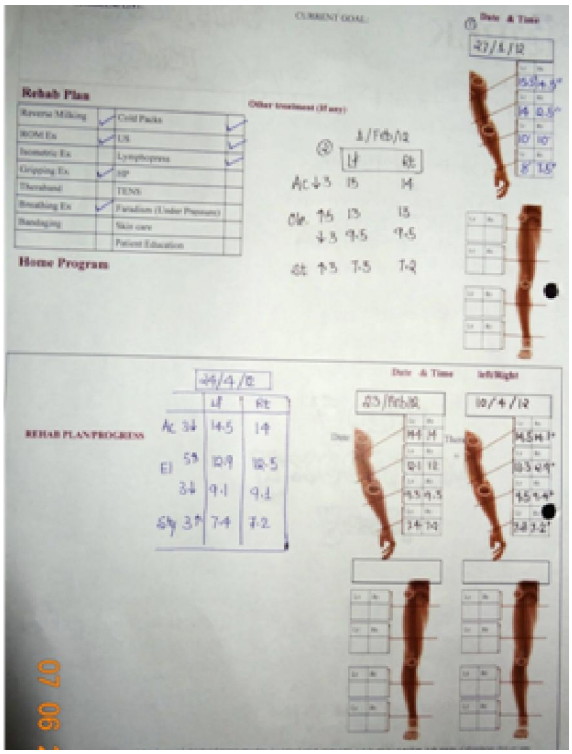
Assessment of patient

Assessment of patients were taken of specific lymphedema assessment forms (Figure: 1).

Apart from clinical history, general skin

Figure 1: Assessment form used for assessment of patients





condition and type of edema, following were assessed:

- Pain using VAS scale
- Detail sensory examination
- Limb girth measurements were taken every 3rd day at following key points:
  - 3 inch below acromion process (in relation to axillary fold)
  - 3 inch above cubital fold (mid arm)
  - 2 inch below cubital fold (mid forearm)
  - 1 inch above palmar crease (wrist)

Both sound limb and affected limb were measured and recorded. Summary of measurement given below in table 2.

Intervention

Intervention given to all patients included complete decongestive physiotherapy (CDPT)

Components of CDPT we used in our intervention

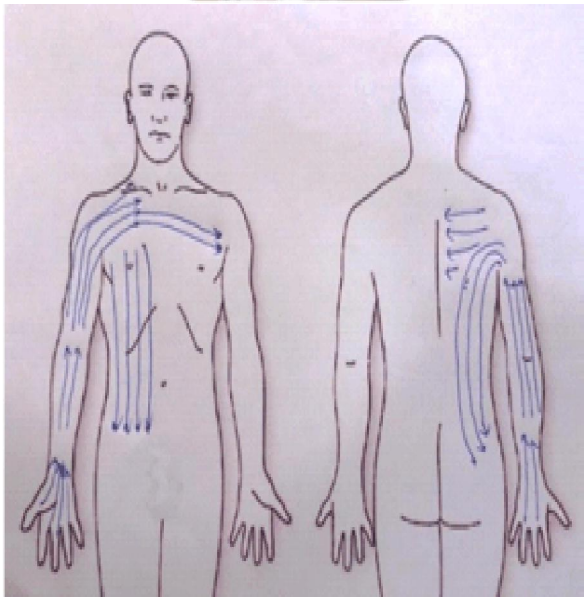
Manual lymphatic drainage

Manual lymphatic drainage therapeutic technique is used for reducing edema and symptoms related with edema by accelerating lymphatic drainage.[1,3] The aim of MLD along the extremity is to provide fluid drainage.[3] Manual lymphatic drainage, consists of hand motions by the therapist on the skin and subcutaneous tissue of patient. Applied pressure is very soft, for suiting the lymphatic pulse beat, applied motions are slow. Every manoeuvre is applied from distal to proximal. Manual lymphatic drainage stimulates the internal contraction of lymphatic channels. If interstitial space concentration of protein is reduced, it provides drainage of obstructed lymph fluid.

Sequential pneumatic compression therapy

Pneumatic compression tools used to treat acute and chronic lymphedema in order to activate extra lymph liquid in affected area. The usage of pneumatic compression tools is contraindicated in acute deep vein thrombosis and inflammatory edema. Generally, these

Photograph 2: Showing Modified manual lymph drainage in process



tools work by applying regular sequential pressure or various-degree pressure to an extremity. Most of tools allow pressure changes between 0 and 300 mmHg. Therapeutic rate depends on diagnosis, but it is usually between 30-60 mmHg.[12]

Multi-layer Compression bandaging

Compression bandaging is used to reduce the increased risk of edema and compensate for the elastic inability of the skin after the

Photograph 3: Showing typical pneumatic compression therapy tool applied on lymphedema patient

decrease of volume. Compression bandaging, increases lymphatic flow and decreases the accumulated protein, increases venous return, shapes suitability and decreases the sizes of the arm, continues the skin wholeness, and protects the arm from probable traumas. The success of compression bandaging depends on patient compliance and cooperation.[1,7,8]

Compression is applied with short stretch bandages. Short-stretch, inelastic bandages have high working pressure and principally use runner strength for muscular system.[1] Compression bandaging is applied from distal to proximal after massage in order to make the fluid flow continue through new ways and avoids the fluid recycling to the edematousarea.[3,7,8] Bandages, according to their features, are applied by trained lymphedema therapists. When the compression bandages are correctly applied, they help decrease swelling and pain. There are bandages in different sizes and they provide pressure at most to 50 mmHg from 20 to 30 mmHg.[9]

Exercise

Exercise is an important part of complete

Figure 2: Showing various steps applying compression bandaging

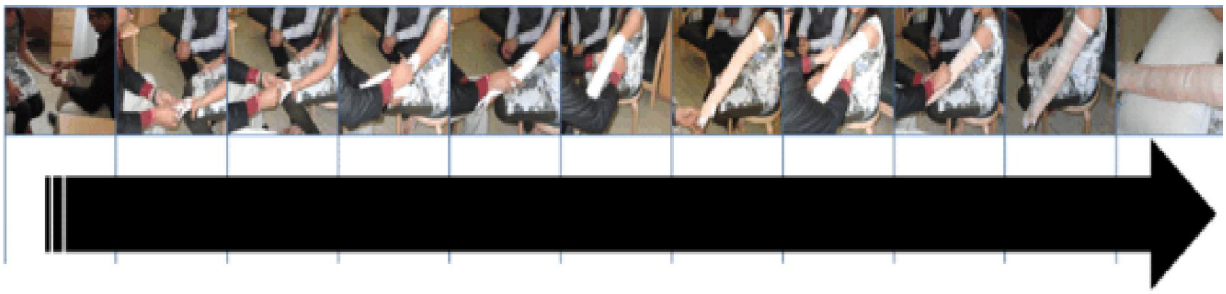


Figure3: Different layer used in multilayer compression bandaging

decongestive physiotherapy for lymphedema management. Therapeutic exercise helps lymph flow and increases the reabsorption of proteins.[9] Exercise increases the physical function of the arm locally and systemically by stimulating the inner contractility of the lymph muscles.[5] The primary role of the lymphatic system during exercise is to help the regulation of tissue volume and to create pressure by carrying liquid and plasma proteins emanated through interstitial interval from the tissue to the cardiovascular system.[12,13] It is determined that exercise did not aggravate the secondary lymphedema for women post breast cancer.[12]

Patient education & Skin Care

Patients must be educated about do's and don'ts to minimise risk of lymphedema. The aim of skin care is to minimize the dermal colonization of bacteria and fungi, in order to control the dryness. Daily cleaning with oil based mineral soaps removes the skin rash and bacteria from the environment while moisturizing the skin.[12,14] The skin must be cleaned with a non-abrasive soap. It is important to keep the nails trimmed, but not

Table 1: Showing summarised detail of intervention plan

Intervention	Frequency	Duration	Description
Modified MLD	6 day a week	30-40 minute session	Consisted of soft pressure superficial technique consisted of circular and longitudinal motion followed by deep reversed milking technique.
Pneumatic compression therapy	6 day a week	20 + 20 minute session	20 minute on sequential rhythmic compression mode followed by 20 minute sequential continuous draining mode.
Compression Bandaging	6 day a week	As applicable	Multilayer compression bandaging applied after every session, patients were instructed to reapply the outer most elastic crepe bandage if become loose, bandage were removed before next session.
Remedial exercises	6 day a week	10 minute	Remedial exercises consisted of ROM exercises for all major joints of upper extremities. Sub maximal strength training with mild theraband

Table 2: Showing limb girth measurement of all 4 cases and total reduction after 15 CDPT sessions

	CASE 1					CASE 2					CASE 3					CASE 4				
	1ST ASSESS		AFTER 15 CDPT SESSION			1ST ASSESS		AFTER 15 CDPT SESSION			1ST ASSESS		AFTER 15 CDPT SESSION			1ST ASSESS		AFTER 15 CDPT SESSION		
	Sound limb	Affected limb	Sound limb	Affected limb	Total Reduction	Sound limb	Affected limb	Sound limb	Affected limb	Total Reduction	Sound limb	Affected limb	Sound limb	Affected limb	Total Reduction	Sound limb	Affected limb	Sound limb	Affected limb	Total Reduction
3 inch below acromion process (in relation to axillary fold)	14.5	15.5	14	14.5	1	13.3	15	14	14	1	13	13.5	13.1	13.2	0.3	12.8	13.4	12.1	12.1	1.3
3 inch above cubital fold (mid arm)	12.5	14	12.5	12.9	1.1	14.9	14	13.6	14	0.9	11.5	12	10.8	10.8	1.2	11	12.2	11.5	12	0.2
2 inch below cubital fold (mid forearm)	10	10	9.1	9.1	0.9	10.9	10.9	10	10.5	0.9	10	11.5	9.5	10.2	1.3	8.9	9.2	8.5	9	0.2
1 inch above palmar crease (wrist)	7.5	8	7.4	7.2	0.4	9	8.5	9	9	0	7.5	9	7.8	7.9	1.1	7	7	7	7	0

to cut the cuticles. Manicures and pedicures are not recommended which could be affected by lymphedema because the unsuitable technique and improperly sterilized equipment can cause infection. The skin must be kept safe from traumas.[3,7,12,14]. Above explained intervention plan is summarised in table 1.

Results & Discussion

In all cases reduction in circumferential

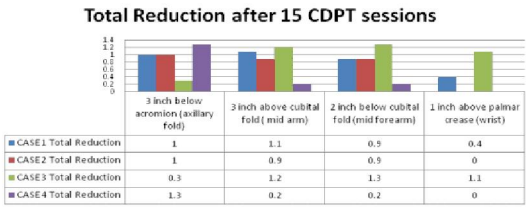
Table 3: Showing clinical characteristics of patients

Case	Case ID	Sex	Age	BMI	Edema grade	Neuropathy signs	Onset after surgery	Skin Changes	Pain
1	3	Female	63 yrs.	22.9kg/m2	Grd 1	No	After 2 year	No	VAS 6
2	8	Female	52 yrs.	25.8kg/m2	Grd 1	No	Within 2 year	No	VAS 6
3	9	Female	62 yrs.	28.9kg/m2	Grd 1	No	Within 2 year	No	VAS 7
4	10	Female	54 yrs.	28.4kg/m2	Grd 1	Tingling sensation occasional	Within 1st year	Very mild	VAS 8

Table 4: Showing total reduction at various measurement key points (measurement unit in inches)

	CASE 1	CASE 2	CASE 3	CASE 4
	Total Reduction	Total Reduction	Total Reduction	Total Reduction
3 inch below acromion (axillary fold)	1	1	0.3	1.3
3 inch above cubital fold (mid arm)	1.1	0.9	1.2	0.2
2 inch below cubital fold (mid forearm)	0.9	0.9	1.3	0.2
1 inch above palmar crease (wrist)	0.4	0	1.1	0

Figure 4: Bar chart showing total reduction after 15 completed CDPT sessions (unit inches)



girth were achieved, maximum reduction note in area where maximum edema was present. Benefits in other symptoms such as pain was archived one case that reported pain in shoulder at first assessment, VAS 8 was reduced to VAS 4 after 15 session, remaining 3 case VAS score after 6 session was 0.

Summarised finding are mentioned in table 3.

Conclusion & Clinical Recommendations

This retrospective case series review suggests that 15 session complete decongestive physiotherapy is effective in the management of lymphedema post mastectomy, its being observed that it helps in reducing the circumferential girth of limb caused by excessive protein rich fluid collection, thus reducing undue pressure and stretch on peripheral nerves and other soft tissue. It is also observed that edema become soft, well-structured patient education helped patients to manage their lymphedema effectively and also their psychological well being were enhanced.

We recommends that CDPT should be considered in management of lymphedema post mastectomy, perhaps we must facilitate prospective clinical controlled research on this

subject with well-structured methodology to establish its efficacy, this retrospective case review has its own methodological limitations, although this report has given us strong background to facilitate more rigorous research in this area.

Acknowledgement

We extend our special thanks to Dr. R. Ranga Rao, Director BLK Cancer Centre, Dr. Amit Aggarwal, Sr. Consultant Medical Oncology, BLK Cancer Centre, Dr. Rama Joshi, Sr. consultant and head Gynae oncology, BLK Cancer Centre, Dr. S.R. Sahni, Sr. Consultant Breast Surgery, BLK Cancer Centre for all their support, knowledge sharing and guidance.

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Case Report

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Effect of Aerobic Exercise on the Blood Lipid Profile in Young Adults: Case Study

Shivani Choudhary*, MPT (CP & IC); Ravinder Narwal, MPT (Cardiopulmonary & Ortho)**

Abstract

Aims & objectives: The aim of the present research was to determine the effect of aerobic exercise training on blood lipid profile in young adults. The path physiology of blood lipid in young adults its increase the atherosclerosis formation on the coronary artery and during the physical inactivity results it developed cardiac diseases. Therefore use of aerobic exercise will be helpful in setting up a better aerobic exercise protocol for improving the lipid profile level and prevention of cardiac disease.

Methodology: This experimental study was carried out with 6 subjects including both male and female with age 20- 30year at college of Himalayan hospital. The data is collected by taking outcome variables in form of blood lipid profile level, BP, THR time.

Protocol: Aerobic exercise 30 minute session/ 5 days/ weeks for 4 weeks with 60 – 70 %THR.

Data analysis: Data was analyzed with parametric test in form of T-test which required with a significant level set at (pd"0.05) and confidence interval was 95%.

Result: There was a beneficial effect of exercise on HDL variables, BP, & THR seen most clearly with the 4 week of aerobic exercise training, other than HDL, BP &THR no other variable has been able to differentiate among both groups.

Discussion: The increase in HDL and decreases the BP, THR time among both group after the aerobic exercise training. Minimal weekly exercise increases the HDL level. BP & THR time are due to the parasympathetic activity.

Conclusions: Aerobic exercise is widely believed to induce changes in the lipid profile, BP & THR time of subjects.

Key words: Aerobic exercise training; Blood lipid profile level; HDL (high density lipoprotein); BP (blood pressure) and THR (target heart rate) & cardiac disease.

Introduction

Coronary heart disease (CHD) is the leading cause of death in India and the leading cause of death worldwide. CHD leads to more death and disability in low and middle income countries and its affects people at younger ages in low and middle income countries.[1] According to world health organization (WHO) bulletins, 1.2 million Indians died from heart disease in 1990 and it predicts that by 2010, 100 million Indians will have heart disease and by 2020, India will super cede all other nations in terms of CAD prevalence.

The WHO reports that in India risk factors for the premature CHD subjects could be multiple, ranging from smoking, sedentary lifestyle, improper diet, abnormal lipids, hypertension, diabetes and obesity and genetic factors.[2] These studies also reported that more than 90 % of acute coronary events can be predicted by major coronary risk factors.[3] In response to the rising incidence of CHD in adults, the AHA and other governing bodies have continued to emphasize the importance of exercise in childhood as a means of preventing CHD later in life (Kavey *et al.*, 2003).[4,5]

CAD is almost always due to athermanous

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narrowing and subsequent occlusion of the vessel. Growth mainly by lipid accumulation of first to third decade of life due to the fatty streak formation , intermediate lesion and the atheroma formation of the intima & media and thrombosis/hematoma formation at the fourth decade of life and it is cause the CAD.[6]

The effect of aerobic exercise on the prevention of atherosclerotic disease has been proved by many epidemiological and experimental studies (Thompson, *et al*., 2003).[7] Regular exercise is effective in reducing the risk of developing arteriosclerotic disease as the biological mechanism (i.e. beneficial effects on atherosclerotic risk factor, myocardial function, coronary artery size and vasodilator capacity and vascular tone, fibrinolysis, platelet function) in many intervention.[7,8]

There is lack of dearth of literature regarding research outcome related to effect of aerobic exercise in blood lipid profile. That's why this study is design on aerobic exercise to find a better effect for prevention of CAD in risk factor subjects and non risk factor subjects.

Methodology

This pilot study was carried out with sample size of 6 subjects who have been selected from physiotherapy department of Himalayan hospital, with CAD risk factors or non risk factor-normal subjects.

Inclusion criteria: Male and female subjects between ages 20–30 yrs were taken with history of smoking, alcoholic, family history of CAD and diabetic, hypertension, obesity, high blood lipid profile level, THR>60-70% max. HR and asymptomatic with all risk factor subjects.

Exclusion criteria: All symptoms with cardiac, vascular, pulmonary, neurological,

Procedure flow chart

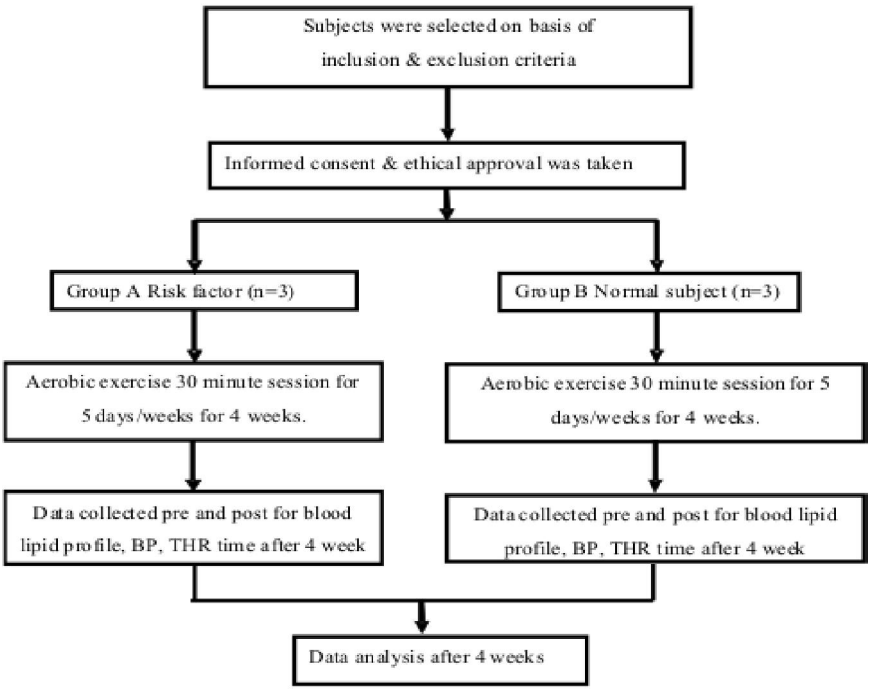


Table 1.1: The comparison of mean of blood pressure intervention both risk factor (group A) and non risk factor (group B).

Variable		Pre (Mean±SD)	Post (Mean±SD)	T valve	P valve
Group A BP	Sys.	130±10.0	125.6±5.7	0.017	0.001
	Dias.	100±10.0	93.3±5.7	1.242	0.001
Group B BP	Sys.	128±10.0	120±0.0	0.354	0.001
	Dias.	93.3±10.0	86±10.0	0.761	0.001

Significance Level (Pd"0.05)

orthopedic and surgical conditions, THR < 80% max. HR on exercise testing.

Variables: Independent variables were aerobic exercise. Dependent variables were in form of blood lipid profile level (Total cholesterol-TC, Low density lipoprotein-LDL, High density lipoprotein HDL, Very low

Figure 1.1: Comparison of mean of cholesterol Level between risk factor (group A) and non risk factor (groupB)

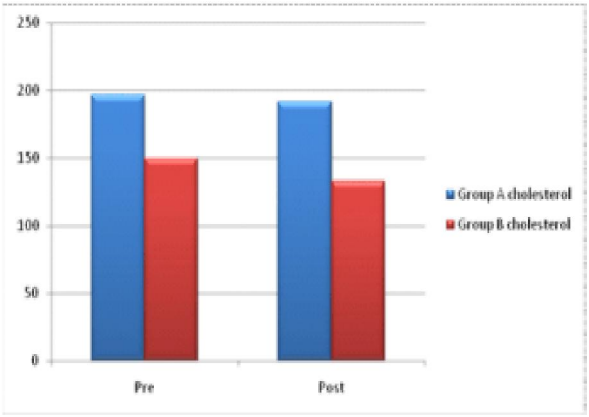


Figure1.2: Comparison of mean of LDL intervention between risk factor (group A) and non risk factor (group B)

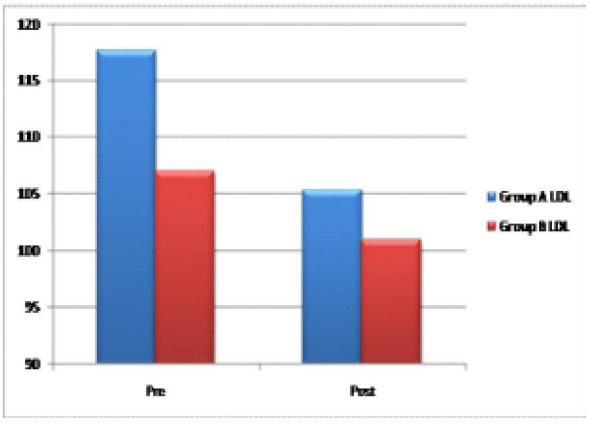


Figure1.3: Comparison of mean of VLDL Level between risk factor (grp A) and non risk factor (grp B)

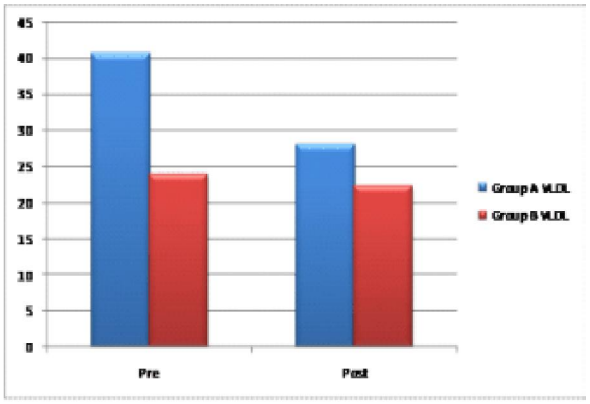


Figure1.4: Comparison of mean of HDL Level between risk factor (grp A) and non risk factor (grp B)

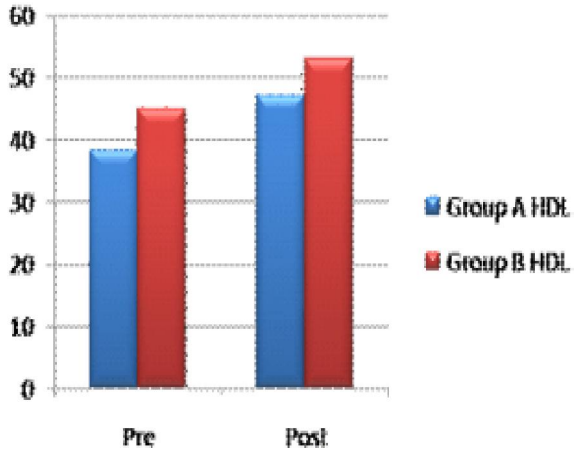


Figure 1.5: Comparison of mean of TG level between risk factor (grp A) and non risk factor (grp B)

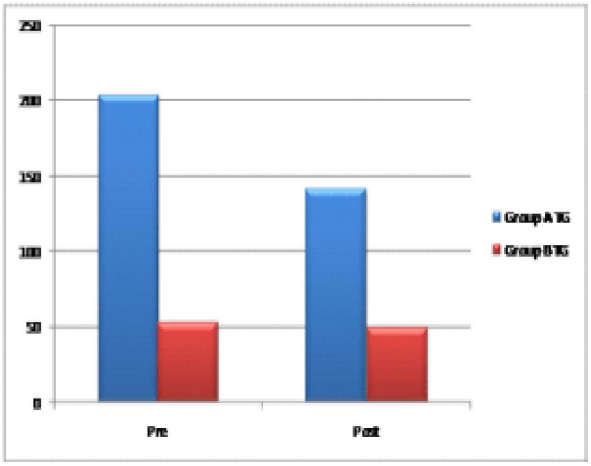
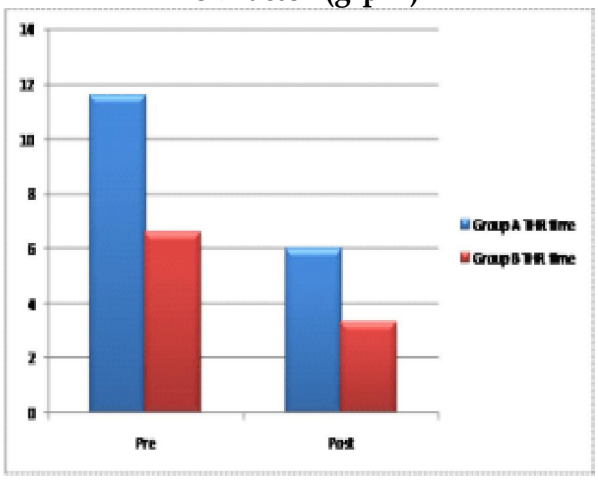


Figure 1.6: Comparison of mean of THRAT level between risk factor (grp A) and non risk factor (grp B)



density lipoprotein VLDL, and Triglysrides TG), Blood Pressure-BP and Target Hear Rate Achievement Time-THART.

Instrumentation: Treadmill, polar heart rate monitor, syphagnomanometer, stethoscope

Data Analysis

The data was analyzed by the statistical package of SPSS-17, graphical pad software as required and significant level was set at pd"0.05 and confidence interval was 95%. The dependent variables used for the comparisons of scientific analysis were blood lipid profile (TC, LDL, HDL, VLDL, and TG), blood pressure and THR time by parametric test in form of pre and post intervention. The intra group comparison was done with the help of mean and standard deviation analysis by paired t test by taking two values in both groups. Inter group comparison was done by unpaired t test as required.

Result

The result presentation of data is based on the two groups including risk factor group-A and non risk factor group-B.

Thus an overall analysis of various scores showed that HDL increase, blood pressure and target heart rate time valve decreased more significantly with four weeks of aerobic exercise training.

Discussion

Result of this research is derived from the sample of six subjects with abnormal blood lipid profile level, blood pressure and THR time based on ratio of male and female 1:1 with a mean age of 20-30 years. Setting of this study is supported that the atherosclerosis formation in the form of fatty streaks formation start at the second to third decade of life and increase the prevalence of coronary artery disease in young adults.

Our study is based on number of physiological variables in form of total cholesterol, low density lipoprotein, high density lipoprotein, very low density lipoprotein, triglycerides, blood pressure and THR time. All these variables are able to represent the improvement of cardiac rehabilitation intervention as described by victor F. Froelicherin their textbook for exercise testing and training.[9] These outcome variables also supported by research studies of Georg A, Kelley, U. Narayani, Kerstin stoedefalke, satoru kodama *et al.*[10, 11, 12]

Pre exercise Comparison of Data

The comparison of all variables before exercise prescription suggest that both group lie at same physiological state (HDL, BP and THR time) and shows no significant difference, so it can be concluded that both groups before treatment lie at same physiological condition.

Post exercise Comparison of Data

1. Discussion of blood cholesterol variable.

The comparison of both group (risk factor and non risk factor group) to see between and within groups shows improvement of blood lipid profile and cholesterol level after four weeks of aerobic exercise training. But this improvement is not significant and it may be

due to the aerobic exercise training required more than 4 weeks of aerobic exercise training to shows significant effect.

George A, Kelley *et al* have suggested that more than 4 week of aerobic exercise reduces total cholesterol, triglycerides and increases high density lipoprotein in adults 18 years of age and older.[10] U. Narayani *et al* have suggested that the total cholesterol decreases and increase high density lipoprotein cholesterol in obese women after six weeks of aerobic exercise and endurance training.[11]

2. Discussion of low density lipoprotein variables.

Risk factor and normal group showed not significant decline in low density lipoprotein from four week by the physiotherapy intervention in the form of aerobic exercise training.

Kelley *et al* suggest that the effect of aerobic exercise training > 8 week are effective in low density lipoproteins level in blood.[10] Kerstin Stoedefalke *et al*, shows that the 15 week aerobic exercise training program resulted in significant decreases in low density lipoproteins.[12]

3. Discussion of high density lipoprotein variable.

The third important finding both the risk factor and normal subject groups shows significant effect after four weeks of aerobic exercise training and this finding supporting the effect of aerobic exercise on high density lipoprotein cholesterol.

Satoru Kodama *et al*, study conclude that the regular aerobic exercise increases high density lipoprotein level it can also shows that the minimal weekly exercise volume for increasing HDL level was estimated to be 900kcal of energy expenditure per week or 120 minutes of exercise per week.[13]

Gilliam and Burke (1978) showed a significant increase in HDL levels with no changes in triglycerides levels in the six week aerobic exercise.[14] Paul D. Thompson *et al*, suggested that the effect of aerobic exercise training in risk factor subjects and normal individual showed a significant effect and increase the high density lipoproteins with the changes of low density lipoprotein.[15]

4. Discussion of very low density lipoproteins variable.

Both groups the risk factor and normal subject group showed non- significant improvement in the very low density lipoproteins outcome from one month after doing aerobic exercise training. The fact behind these changes may be due to the aerobic exercise training more than four week of aerobic exercise training to shows significant effect.

William E. Kraus *et al*, shows the highest amount of weekly exercise, with minimal weight change, had widespread beneficial effects on the lipoprotein profile. The improvements were related to the amount of activity and the intensity of exercise or improvement in physical activity of the subject.[16]

5. Discussion of triglycerides variable.

The risk factor and normal subjects group shows not significant effect in the triglycerides level outcome from one month aerobic exercise training protocol. It may be due to the duration of the aerobic exercise training.

George A. Kelley *et al*, suggest that the more than 8 weeks of aerobic exercise training reduces the triglyceride level of the lipoprotein in men 18 years of age and older.[10] William E. Kraus *et al*, showed the duration and the amount of the aerobic exercise training had beneficial effects on the lipoprotein profile.[16] Ignigo and Mahon *et al*, suggest that the effect of ten week aerobic exercise training program had on triglycerides.[17]

6. Discussion of blood pressure variable.

The next important physiological finding in the form of BP within group and between

groups shows significant effect after four weeks of aerobic exercise training.

Robert H. Fagard *et al*, have suggest that aerobic exercise training decreases blood pressure through a vascular resistance , in which the sympathetic nervous system and due to the involvement of the rennin angiotensin system.[18]

The fact that the decrease of HR is counterbalanced by an increase in stroke volume with unchanged CO is compatible with the generally accepted effect of aerobic exercise training on resting hemodynamic. A decrease in the activity of the autonomic nervous system is most likely involved in the training induced reduction of BP.

7. Discussion of THR time variable.

The next important finding comparison of THR time in risk factor group shows significant effect on exercise training this may be due to the both group having the low level of parasympathetic tonicity or activities which is significantly strengthen by the four week of aerobic exercise training. So one week of aerobic exercise training is effective for THR time and increasing the endurance capacity.

Conclusion

On the basis of our result it can be concluded that TC, TG, VLDL and LDL required more than four week of aerobic exercise training for improvement by both groups.

HDL is the only cholesterol variables which show the significant effect .so four weeks of aerobic exercise training are improve the HDL lipid valves. It can be associated HDL is a heart protective cholesterol. It can be to counter effect the LDL, VLDL level.

Aerobic exercise training significant effects on BP mean systolic and diastolic and it can improve cardiac endurance and better parasympathetic activity. Four week of aerobic exercise training is effective for in increasing the endurance capacity.

Therefore aerobic exercise training should be incorporated in rehabilitation protocol of CAD patients which in turn will help in improving their quality of life and improvement of physiological parameters.

Clinical Relevance

Aerobic exercise training is best for improvement of the marked decrease in the serum cholesterol level was associated with a correction of endothelial dysfunction , improvement in myocardial perfusion , and decrease in the incidence of CAD .Subject with risk factors such as diabetes, hypertension, hypercholesterolemia and smoking effect the affect endothelial function and latter on lead to atherosclerosis.

So exercise training improves the endothelial function of arteries and reduces the risk factors after aerobic exercise training. Therefore, aerobic exercise has proved as a valuable and preventable tool of cardiac rehabilitation. Aerobic exercise improves cardio-pulmonary endurance, quality of life, makes them fit and its help in better life.

Future research & Limitation of study

This study is limited to a very small sample size. So it is strongly recommended for future research based on large sample size and aerobic exercise protocols may be tried more than four weeks.

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