A Study to Evaluate Subclinical Muscle Strength Decrease and Quality of Life among Diabetes Individuals

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Abstract

Background : Diabetes mellitus is a metabolic disorder of multiple aetiologies characterized by chronic hyperglycemia resulting from defects in insulin secretion or insulin action. Muscle strength is influenced by insulin resistance, through higher plasma levels, and lipid content in the muscle, therefore it could be a marker for impaired skeletal muscle. These structural and functional changes in the skeletal muscle caused by defective insulin action could be associated with muscle weakness and reduced endurance capacity. This study evaluates the subclinical changes in muscle strength in diabetes and its functional performance comparing with age-matched healthy subjects.

Methods: This observational study totally includes 80 male and female individuals, 40 of type 2 DM and another 40 of age matched healthy individuals without any difficulty in Activities of daily living were recruited above 60 years of age, and assessed with HHD and functional measure (FTSTS) and quality of life measure (SF 36) used.

Results: Independent sample T test and Pearson correlation coefficient was used to analyze the difference and correlate among lower extremity muscle strength, FTSTS, and SF 36 in diabetic and healthy individuals; the data obtained were statistically significant, except SF 36 emotional limitation and physical limitation factor were non-significant. Pearson's coefficient found to have weak negative correlation in SF 36 and muscle strength.

Conclusion: Type 2 diabetes mellitus has correlated with reduction in muscle strength particularly in lower limb which remains subtle and unidentified as the disease progresses the muscle weakness may become progressive and lead to immobility.

Key words*: Type 2 diabetes mellitus, subclinical, lower extremity, muscle strength*

Introduction

Diabetes mellitus (DM) is a chronic metabolic disease which is characterized by an increase in blood glucose level resulting from a relative insulin deficiency or insulin resistance [1]. Numerous studies have highlighted various complications of DM, which includes vision loss, chronic kidney disease, reduced muscle strength and other long term consequences that have a significant influence on the quality of life of an individual [2].

DM is often accompanied by loss of mobility which can have a major impact on the independence of an individual. Limited mobility leads to inactivity and henceforth leads to loss of muscle mass resulting in decreased muscle strength [3]. Even though musculoskeletal manifestations like muscle weakness significantly compromises the quality of life among the diabetes mellitus population during the later stages, muscle weakness is usually subclinical which means the symptoms are not severe enough to produce observable clinical manifestation, therefore it is less valued, and adequate importance was not given for evaluation of

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muscle strength in clinical practice.

Long lasting suboptimal glycemic control is associated with protein catabolism in skeletal muscle that may lead to sarcopenia, muscle fat infiltration leading to loss of muscle strength and reduced functional capacity [4]. There is a strong association of diabetes with lower extremity muscle strength reduction and quality of life. The mechanism for lower extremity weakness is due to the accumulation of Intramuscular Noncontractile Tissue (IMNCT) particularly in lower limb which may contribute to a reduction in muscle blood flow and in turn lead to insulin dysfunction capacity increasing the fatty acids and resulting in the insulin resistance of skeletal muscle [5].

There is no evidence demonstrating the muscle strength evaluation as a subclinical factor, in well ambulatory and well-functioning older adults with diabetes and comparing with normal subjects of same age and Body Mass Index (BMI). Lower extremity muscle strength loss remains subtle and unidentified among the diabetic individual; hence do not exhibit major changes in their quality of life, later stages this may lead to severe muscle weakness and impaired mobility.

There are evidences showing muscle strength decrease has been related to functional limitation and quality of life which was evident in diabetic individual, so we decided to identify the impact of muscle strength with functional performance and quality of life, using Five Times Sit To Stand (FTSTS) and for quality of life (QOL) 36-Item Short Form Survey (SF-36) questionnaire will be evaluated for both diabetic and age-matched healthy individuals.

The main objective of this study is to determine whether a clinical scenario might exist where there will be a subclinical muscle power decrease without any reflections on functions performed and quality of life in diabetic individuals when compared with age-matched healthy individual and to identify the association between DM and muscle strength in the lower extremity and their influence on the quality of life.

Aim of the Study

The aim of the study is to identify the subclinical lower extremity muscle strength decrease among type 2 diabetic individuals with age-matched healthy individuals.

Objectives

To correlate the lower extremity muscle strength with functional performance and quality of life in diabetic and healthy individuals.

Methodology

The study protocol was approved by the Institutional ethics committee for student proposal of Sri Ramachandra Institute of Higher Education and Research (SRIHER) and obtained REF: CSP/18/SEP/73/253. This study was registered in Clinical Trial Registry-India(CTRI) with registration number CTRI/2019/01/016824.

This observational study includes 80 male and female individuals, in which 40 are type 2 DM and another 40 are age-matched healthy individuals without any difficulty in Activities of daily living were recruited from SRIHER, Endocrinology and Diabetes department. Convenient sampling was used, and written informed consent was obtained from every individuals. Inclusion criteria includes: Male and female subjects with type 2 DM of known duration, HbA1c levels and aged above 60 years. He/she should be cooperative and able to understand instruction given by the therapist. The diabetic individuals are compared with healthy individuals without any known comorbidities. They should have good functional transitional movements like, sitting without support, sit to stand and able to walk independently, and excluding cardiac and renal insufficiencies, muscular disorders/rheumatoid arthritis foot ulcers/foot amputations, and complaints like difficulty to perform activities of daily living, usage of mobility aids to get around or any other neurological impairments.

Basic demographic data (age, gender, BMI) was obtained from both groups **Instrumentation:**

Maximal isometric strength was measured using Handheld Dynamometer (HHD) force gauge. The testing of muscle strength was performed in high sitting position for Knee Extensors, Ankle DF and supine lying for Ankle PF [8, 9]. The subject was shown a demonstration of the movement before being tested. All measurements were taken for bilateral lower extremities for both

diabetic and age matched healthy individuals.

Outcome Measure

FTSTS: The individuals will be asked to do sit to stand from 43 cm high armless chair, quick as possible, for 5 repetitions with instructions to cross their arms across the chest and perform sit to stand completely, making firm contact during sitting. Timing will begin with the command given by therapist and will end by the stopwatch when individuals sit after 5th stand up. Two trials were taken and the better one was considered for this analysis.

Rand SF-36 questionnaire: This questionnaire contains 36 items of health related measure based on functional status, well-being and overall evaluation of health. The higher score at SF 36 questionnaire better functioning and positive outcome under health related QOL will be present; scoring will be done by SF36 online calculator.

Results

SPSS software version 17.0 used for Independent T- test and Pearson correlation coefficients. 40 Healthy individuals (male, female) and 40 type 2 diabetic individuals (male, female) were assessed. Age, BMI were matched with diabetic patients and healthy individuals.

Table 1: Comparison between Lower Extremity Muscle Strength, FTSTS and SF 36 in diabetic and healthy individuals

Variables	Type 2 Diabetic individuals	Healthy individuals	p value
	Mean (SD)	Mean(SD)	
R Knee Ext	9.452(2.59)	14.91(3.44)	.000
R Ankle DF	6.087(1.77)	10.73(2.52)	.000
R Ankle PF	9.07(1.40)	14.19(2.25)	.000
L Knee Ext	9.147(2.33)	14.71(3.2)	.000
L Ankle DF	6.194(1.79)	10.95(2.56)	.000
L Ankle PF	8.93(1.68)	13.95(2.58)	.000
FTSTS	15.52(3.02)	11.34(1.61)	.000
SF36- Physical Functioning	78.75(12.74)	90.37(9.76)	.000
SF 36 –limitation physical	100(0.00)	100(0.00)	NA
SF 36-limitation- emotional	99.15(5.37)	100(0.00)	.320
SF 36-energy fatigue	80.13(13.75)	86.08(10.14)	.031
SF 36-emotion-well being	79.10(17.80)	93(10.50)	.000
SF 36- social	84.80(18.25)	94.77(6.78)	.002
SF 36-pain	85.93(15.67)	91.93(10.53)	.048
SF 36-general health	58.25(10.65)	64.05(10.95)	.019
SF 36-heath change	65.62(20.94)	78.5(19.45)	.006

In Table 1, Independent sample T test was used to analyze the difference between lower extremity muscle strength, FTSTS, and SF 36 in diabetic and healthy individuals; the data obtained were statistically significant, except SF 36 emotional limitation and physical limitation factor were non-significant between these two groups.

Reduced muscle strength in lower extremities was found in diabetic individuals when compared with healthy individuals. The time taken to perform FTSTS was higher in diabetic individuals, when compared with healthy individuals indicating reduced functional strength.

Table 2: Correlation between muscle strength and SF-36 measure in diabetic individuals

SF 36	Knee extensor R	Knee extensor L	Ankle dorsiflexor R	Ankle plantarflexor L	Ankle dorsiflexor L	Ankle plantarflexor R
Physical function						
r value	-0.003	0.028	-0.067	0.084	-0.054	0.11
p value	0.987	0.862	0.683	0.257	0.74	0.499
Limitation –physical	Nil	Nil	Nil	Nil	Nil	Nil
Limitation- emotional	Nil	Nil	Nil	Nil	Nil	Nil
Energy fatigue						
r value	-0.001	-0.136	-0.325	-0.31	-0.309	-0.195
p value	0.996	0.404	0.04	0.052	0.052	0.227
Emotional wellbeing						
r value	-0.161	-0.066	0.032	0.01	0.01	-0.018
p value	0.322	0.685	0.845	0.953	0.949	0.911
General health						
r value	-0.051	-0.014	-0.101	0.274	0.005	0.218
p value	0.757	0.933	0.536	0.087	0.974	0.176
Health change						
r value	0.266	0.309	0.147	0.274	0.244	0.178
p value	0.097	0.052	0.364	0.087	0.128	0.272
Social						
r value	-0.027	-0.063	-0.058	-0.137	-0.087	-0.215
p value	0.868	0.699	0.723	0.398	0.593	0.182
Pain						
r value	0.027	-0.047	0.082	-0.038	0.085	-0.163
p value	0.614	0.772	0.614	0.814	0.602	0.315

In Table 2, Correlation among muscle strength in diabetic individuals with SF-36 Measure was done. The results shows Weak negative correlation and non-significance.

Discussion

The results in this study reveal that individuals with diabetes mellitus had a significant reduction in lower extremity muscle strength when compared with their normal counterparts which is supported in the studies earlier as adults with type 2 diabetes had a reduced muscle strength, than those without diabetes and muscle quality consistently reduced regardless of sex and muscle groups. This explains the risk of functional limitation and disability with type 2 diabetes [10].

Even though lower extremity muscle strength reduction was obvious it proved to be subclinical, i.e. the diabetic individuals did not exhibit any changes in their daily activities and did not show an obvious decline in the scores of quality of Life. Evidence shows lower extremity muscle strength is reduced in type2 diabetes people, with or without polyneuropathy and is associated with impaired mobility and reduced quality of life [3]. In contrast, our present study showed the diabetic individuals did not show ambulatory difficulties, reduction was shown in physical functioning, energy fatigue, emotional well-being, social, pain, general health, health change in QOL measure but no changes seen in physical and emotional limitation factor.

Functional lower extremity muscle strength was evaluated by FTSTS, it showed a similar decline in strength for diabetic. This measure showed increased time duration to perform sit to stand activity in diabetic individuals, which reveals an apparent decline in lower extremity functional strength even though they did not exhibit any variation in the activity of daily living. In the previous studies, a longer FTSTS time has found to predict falls and disability in older adults and the performance of FTSTS in our diabetic individuals was found to be poorer than age-matched non-diabetic individuals [7]. The diabetic individuals even though are able to ambulate and perform their daily activities these changes remain subtle and may lead to permanent disability in the future.

This study further found that the ankle dorsiflexors strength was reduced significantly among diabetic individuals. According to the earlier study, dorsiflexors is the only significant determinant for FTSTS. The ankle dorsiflexor torque not only can stabilize the contact between the feet and the ground but also rotate the lower leg forward and help to add to the knee extension torque in bringing the body forward and upward [7]. The ability to generate ankle dorsiflexion torque (i.e. Ankle DF strength) could be particularly important for the diabetes group who had poorer knee extension strength. This could be the reason for the poor performance of FTSTS in the diabetes group.

The findings in our study shows the fact that longer duration and poor glycemic control, in diabetic was associated with marked reduction in lower extremity muscle strength which strongly suggests that the duration and severity of diabetes plays a very important role in muscle strength, and no association was found in age, BMI, newly diagnosed diabetes. The severity of diabetes had a negative correlation with FTSTS and lower extremity muscle strength. The HbA1c levels found to have a negative correlation with knee extensors in diabetic individuals, other values showed a positive correlation indicating that the HbA1c level does not influence distal muscle strength.

Earlier studies suggested that no single factor explained the association of diabetes and disability, several comorbidities and impairments could be the causes of disability among diabetes [6]. Factors like obesity, depression may be associated with disability. Even though the findings cannot be used to impute the association between diabetes and reduction in muscle strength in lower extremity, the results do suggest that reduction of muscle strength is related to diabetes, and in spite of it, increased duration in FTSTS participants in this study did not have any ambulatory impairments and remained unidentified which prove the hypothesis that it is subclinical and more obvious only in diabetic individuals than normal individuals.

Based on the above results we can conclude that individuals with type 2 diabetes mellitus had a reduction in muscle strength particularly in lower limb which remains subtle and unidentified and as the disease progresses the muscle weakness may become progressive and lead to immobility and various musculoskeletal complications.

Limitation

Reduced sample size in diabetic individuals

Future Studies

To include large number of DM population with varied duration

To develop an exercise protocol for lower limbs, to prevent any further decline in mobility.

Conclusion

Type 2 diabetes mellitus has a reduction in muscle strength particularly in lower limb which remains subtle and unidentified and as the disease progresses the muscle weakness may become progressive and lead to immobility and various musculoskeletal complications. The decline in lower extremity muscle strength resulted in longer duration with FTSTS in diabetic individuals but it did not show any changes in ambulation and quality of life, thus it becomes very mandatory to evaluate lower extremity muscle strength at early stage of diabetes to prevent musculoskeletal complications at the later stages.

Source of Funding- Self

Conflict of Interest- Nil

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