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**INTERNATIONAL JOURNAL OF
 ADVANCED RESEARCH (IJAR)**

Article DOI:10.21474/IJAR01/5381
 DOI URL: <http://dx.doi.org/10.21474/IJAR01/5381>



RESEARCH ARTICLE

COMPARISON OF MINI-BESTest VERSUS BERG BALANCE SCALE TO EVALUATE BALANCE DISORDERS IN PARKINSON'S DISEASE.

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Manuscript Info

Abstract

Manuscript History

Received: 09 July 2017
 Final Accepted: 11 August 2017
 Published: September 2017

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Introduction:-

Parkinson's Disease (PD) is a disorder of the central nervous system, involving primarily a degeneration of certain nerve cells of the basal ganglia, and in particular, a loss of nerve cells in the substantianigra. These cells produce the neurochemical messengers dopamine, which is partly responsible for starting a circuit of messages that coordinate normal movement. In the absence of dopamine, the neurons in the receiving area in the striatum are not adequately stimulated and hence leads to impairments of movement with tremor, slowness, stiffness or balance problems.¹

Postural instability is a common cause of falls in people with PD.² In contrast to community dwelling adults over age 65, approximately 1/3rd of whom report falling each year³, upto 70% of individuals with PD fall once annually, while 50% fall twice or more in one year period.^{4,5} Falls lead to a myriad of complications⁶ that can affect not only physical health, but also the psychological health of the individual.

Due to the negative impact of balance impairments individuals with PD, it is important to be able to assess who has a balance deficit and is at increased risk of falling. Identification of those at risk is essential in order to intervene, as physical therapy and exercise have been shown to improve balance.⁷ There are many different balance outcome measures and fall risk assessments are being used in individuals with PD.⁸⁻¹² Many of these measures have limitations exist including low sensitivity and/or specificity^{8,13} ceiling effects^{16,15} and inclusion of items that physical therapy intervention cannot address (such as prior number of falls).^{11,16,17} Some research has shown that a battery of tests is necessary to fully assess balance, however, a consensus on which tests to include and interpretation of results from multiple tests has not been reached.^{9,13,18} To evaluate postural stability in a more functional context, these clinical scales would appear to be more appropriate than simple tests of postural stability.

The Berg Balance Scale (BBS)¹⁹ is one of the most valid and reliable measure to assess balance.²⁰ However, there are some important limitations of BBS such as the need for some rescoring of the rating scale,²² a ceiling effect,²¹ problems with underutilization and redundancy of categories due to the rating scale. These particular limitations are important considerations when evaluating patients with mild neurological deficits, who are easy to identify and therefore less likely to receive rehabilitation and relatively low responsiveness.²³ Furthermore, dynamic balance is unexplored by the BBS.

A new clinical tool for assessing balance impairments has been presented : the Balance Evaluation Systems Test (BESTest).²⁴ It is a 36- item test which also evaluates dynamic balance and gait performance and has a good reliability and validity for assessing balance in individuals with PD.²⁵ It consumes 45 mins to administer the test and comprises multiple dimensions.²⁶ Hence considering the aid of factor and Rasch analysis, a short form of the BESTest with 14 items only, named Mini-BESTest, was produced, with improves rating category, high reliability and structural validity.²⁶ The Mini BESTest includes important aspects of dynamic balance control, such as the capability to react to postural perturbations to stand on a compliant or inclined surface, or to walk while performing a cognitive task. All these features of balance control are known to be important in assessing balance disorders in different types of patients and reflect balance challenges during activities of daily living.^{24,27} The aim of this study is to perform a head-to-head comparison of the psychometric performance of Mini-BEST and BBS in PD patients for Indian population.

Aims & Objectives:-

AIMS:-

To Compare the Mini-BESTest versus Berg Balance Scale to Evaluate Balance Disorders in Parkinson's Disease.

Objectives:-

The objectives of study therefore are :

1. To evaluate sensory orientation in patients with Parkinson's Disease.
2. To identify balance deficits in patients with mild PD.
3. To check the components of balance with Mini-BESTest against gold standard Berg Balance Scale for Indian population.

Review of Literature:-

Andrea Giordano et al did "Comparison of reliability, validity, and responsiveness of the Mini-BESTest and Berg Balance scale in patients with Balance Disorders" recruited 97 subjects with balance deficits. Mini-BESTest , Berg Balance Scale and Global Rating of Change Scale were used as outcome measures. Results suggested that Test-retest reliability for total scores was significantly higher in Mini-BESTest (ICC=0.96) than in BBS (ICC=0.92), whereas inter-rater reliability was similar (ICC = 0.98 vs. 0.97). In Receiver Operating Characteristic (ROC) curves, the area under the curve was 0.92 for Mini-BESTest and 0.91 for BBS. The best Minimal Important Change (MIC) was 4 points for Mini-BESTest and 7 for BBS. After treatment, 38 patients at Mini-BESTest vs. only 23 at BBS (out of the 40 subjects who had a GRC >3.5) showed a score change equal or greater than MICs.³⁹

Abigail L. Leddy, et al conducted "Utility of the Mini-BESTest, BESTest, and BESTest Sections for balance assessments in Individuals with Parkinson Disease" in 2011 on 80 individuals with idiopathic PD who were assessed using the BESTest and Mini-BESTest. The Mini-BESTest, total BESTest score, and all sections of the BESTest, showed a significant difference between the average scores of fallers and non-fallers. For both the Mini- BESTest and BESTest, inter-rater (intra-class correlation $ICC \geq 0.91$) and test-retest ($ICC \geq 0.88$) reliability was high. The Mini-BESTest and BESTest were highly correlated ($r=0.955$). Accuracy of identifying a faller was comparable for the Mini-BESTest and BESTest (area under the ROC plots =0.86 and =0.84, respectively).³⁶

Margaret K. Y. Mak et al conducted a study entitled "The Mini-BESTest can predict Parkinsonian recurrent fallers: A 6-month prospective study" on 110 patients with Parkinson's Disease. The tests used were Unified Parkinson's Disease Rating Scale (MDS-UPDRS III), Freezing of Gait Questionnaire, Five-Time-Sit-To-Stand Test, and Mini-BESTest. All patients were followed by telephone interview for 6 months to register the incidence of monthly falls. The results indicate that those with a Mini-BESTest score < 19 at baseline had a significantly higher risk of sustaining recurrent falls in the next 6 months. These findings highlight the importance of evaluating dynamic balance ability during fall risk assessment in patients with Parkinson's Disease.²⁵

Mia Conradsson et al published a study entitled " Berg Balance Scale: Intrarater Test-Retest Reliability Among Older People Dependent in Activities of Daily Living and Living in Residential Care Facilities" in which 45 older people (36 women and 9 men) who were living in 3 residential care facilities were included and BBS was assessed twice by the same assessor. Results revealed that the absolute reliability calculated was 7.7 points, and the ICC was calculated to 0.97. Hence, the absolute reliability showed that a change of 8 BBS points is required to reveal a genuine change in function among older people who are dependent in activities of daily living and living in

residential care facilities. This knowledge is important in the clinical setting when evaluating an individual's change in balance function over time in this group of older people.⁴⁰

Ryan P. Duncan et al in the study entitled "Accuracy of Fall Prediction in Parkinson Disease: Six-Month and 12-Month Prospective Analyses" analyzed the ability of four balance assessments to predict falls in people with Parkinson Disease (PD) prospectively over six and 12 months in which: The BESTest, Mini-BESTest, Functional Gait Assessment (FGA), and Berg Balance Scale (BBS) were administered to 80 participants with idiopathic PD at baseline. Falls were then tracked for 12 months. Ability of each test to predict falls at six and 12 months was assessed using ROC curves and likelihood ratios (LR). Results revealed that twenty-seven percent of the sample had fallen at six months, and 32% of the sample had fallen at 12 months. At six months, areas under the ROC curve (AUC) for the tests ranged from 0.8 (FGA) to 0.89 (BESTest) with LR+ of 3.4 (FGA) to 5.8 (BESTest). At 12 months, AUCs ranged from 0.68 (BESTest, BBS) to 0.77 (Mini-BESTest) with LR+ of 1.8 (BESTest) to 2.4 (BBS, FGA). This pilot study suggests that people with PD should be assessed biannually for fall risk.⁴¹

Methods & Materials:-

Prior to commencing the study, the study proposal was prepared and submitted to "Human Research Ethics Committee" of H. M. Patel Centre for Medical Care and Education, Karamsad for its approval and permission to begin the study.

Study Design:-

Cross Sectional Study

Sample Size:-

77 participants with PD aged 40-69 years were recruited as per the subject recruitment procedure.

Study Setting:-

K M Patel Institute of Physiotherapy (KMPIP), Shree Krishna Hospital, Karamsad, Gujarat.

Inclusion Criteria:-

Patients diagnosed with idiopathic PD by a neuro-physician between the age group of 40 yrs to 69 yrs of both gender were included in the study.

Exclusion Criteria:-

Patients with cognitive impairments, Mini-Mental State Examination score of < 24

Prior orthopaedic injuries or impairments that could interfere with mobility such as artificial joints or peripheral neuropathy, prior brain surgery, diagnosed case of neurological disorder, non-ambulatory Parkinson's patients.

Participant Recruitment Procedure:-

All the participants who were referred for physiotherapy treatment at KMPIP adult neuro unit, Shree Krishna Hospital, Karamsad, and those who visited neurophysician OPD in Shree Krishna Hospital, Karamsad and who fulfilled the inclusion criteria were recruited in the study.

Materials used were case record sheet, informed consent forms, UPDRS, Mini-BESTest Scale, Berg Balance Scale, chair without arm rests or wheels (17 inches), incline ramp, stopwatch, a box (9" height), 3 meter distance measured out and marked on the floor with tape [from chair]

Methodology:-

Informed consent form from participant or primary caregiver of all the patients was obtained after explaining the purpose of the study. Primary details were obtained which includes demographic data, clinical profile about higher mental functions, tone, range of motion, functional manual muscle testing, balance assessment using BBS and Mini BESTest scale, UPDRS (III): a disability rating scale used to examine the motor component in Parkinson's Disease, also Hoehn&Yahr staging was used to classify the severity of the disease.

The detail of administration of scales is as under.

BBS:-

The Berg Balance Scale (BBS)¹⁹ is one of the most widely used tools for balance assessment.²⁰ Its psychometric properties have been well assessed, and the scale has shown to be a valid and reliable measure of balance.²¹ It is composed of 14 items that require subjects to maintain positions of varying difficulty and perform specific tasks such as standing and sitting unsupported, transfers (sit to stand and stand to sit), turn to look over shoulders, pick up an object from the floor, turn 360° and place alternate feet on a stool. Scoring is based on the subject's ability to perform the 14 tasks independently and/or meet certain time or distance requirements. Each item is scored on a 5-point ordinal scale ranging from 0 (unable to perform) to 4 (normal performance) so that the aggregate score ranges from 0 to 56. Time consumed is 15-20 minutes.

Materials And Tools:-

Ruler, two standard chairs (one with arm rests, one without), footstool or step, (6 inches), stopwatch or wristwatch, 15 ft walkway

Mini-Bestest:-

The Mini-BESTest is a 14-item balance scale which takes about 15 minutes to administer, is uni-dimensional and highly reliable.²⁶ It contains items covering a broad spectrum of performance tasks, including transitions and anticipatory postural adjustments, postural responses to perturbation, sensory orientation while standing on a compliant or inclined base of support, and dynamic stability in gait. Items are scored from 0 (unable to perform or requiring help) to 2 (normal performance). The maximum total score is 28. Time consumed is 10-15 minutes.

Materials And Tools:-

Chair without arm rests or wheels, (17 inches), incline ramp, stopwatch, a box (9" height), 3 meter distance measured out and marked on the floor with tape [from chair]

Both the tests were performed consecutively one after the other with adequate amount of rest interval in between the tests (maximum 15 minutes). All the necessary precautions for the participants' safety were taken care of.

Observation & Results:-

The data were fed into computer using Microsoft Excel sheet. For statistical analysis, SPSS (Statistical Package for Social Sciences) software version 14.0 was used. Descriptive statistics like frequency (%), mean (SD) were used for different variables. The STATA statistical package was used for both calculations and graphics²⁸.

Figure 1 describes the Berg and Mini-BESTest data for the 77 participants, using a scatter plot displaying the association between the two variables. Multiple Linear Regression was carried out on UPDRS jointly on the two scores for the Berg and Mini-BESTest. This regression provides information on the relative contributions of the Berg and Mini-BESTest for predicting the UPDRS. In this study the relative performance of the Berg and Mini-BESTest in terms of receiver operating characteristic (ROC) curves for classifying people into two groups based on a threshold for the H&Y score, to discriminate between mild PD (H&Y 1-2) versus more severe PD (H&Y 3-4)²⁹ is considered.

		FREQUENCY	PERCENTAGE(%)
GENDER	MALE	50	64.9
	FEMALE	27	35.1
H&Y	1-2	64	83.1
	3-4	13	16.9

Table 1 :- Descriptive of Variables

Table 1 describes the frequency and valid percentage in which there are 50 male participants and 27 female participants which is showing 64.9% and 35.1% respectively in accordance with the frequency. Also the table shows the frequency and percentage for Hoen&Yahr stages 1 to 4 in which 1&2 stage signifies less postural deficits while 3&4 stage patients have postural deficits according to the classification. For stage 1&2 there is 16.9% and for 3&4 stage there is 83.1% in accordance with the frequency.

	MEAN	SD
AGE	59.20	5.5
UPDRS(III)	45.61	4.02
H&Y	2.06	0.695
BBS	43.42	5.61
MINI-BESTest	15.56	2.07

Table 2:-Participants characteristics.

BERG TEST COMPONENT	PERCENTAGE (% achieved full score)	MINI-BESTest COMPONENT	PERCENTAGE (% achieved full score)
Sitting to standing	64.9%	Change in gait speed	67.5%
Standing unsupported	27.3%	Rise to toes	66.2%
Sitting with back unsupported but feet supported on floor or on a stool	27.3%	Sit to stand	63.6%
Pick object from floor from standing position	26.6%	Timed up & go with dual task	54.5%
Standing unsupported one foot in front	26%	Step over obstacles	51.9%
Place alternate foot on step or stool while standing unsupported	26%	Walk with head turns horizontal	40.3%
Standing unsupported with feet together	26%	Walk with pivot turns	39.0%
Reaching forward with outstretched arm while standing	24.7%	Stand on one leg	37.7%
Turning to look behind over left and right shoulders while standing	23.4%	Compensatory stepping correction forward	33.5%
Standing on one leg	23.4%	Compensatory stepping correction backward	29.9%
Standing to sitting	23.4%	Compensatory stepping correction lateral	28.6%
Transfers	23.4%	Feet together, eyes open, firm surface	7.8%
Turn 360 degrees	22%	Feet together, eyes closed, foam surface	3.9%
Standing unsupported with eyes closed	18.2%	Incline- eyes closed	2.6%

Table 3:-Describes the percentage of population in BBS and Mini-BESTest scoring full score showing the components which are difficult for the patients with PD.

Correlation co-efficient to find relativeness between the variables shows a strong positive association between Mini-BEST and BBS ($r = 0.732, 0.750$) with p value < 0.0001 is statistically significant.

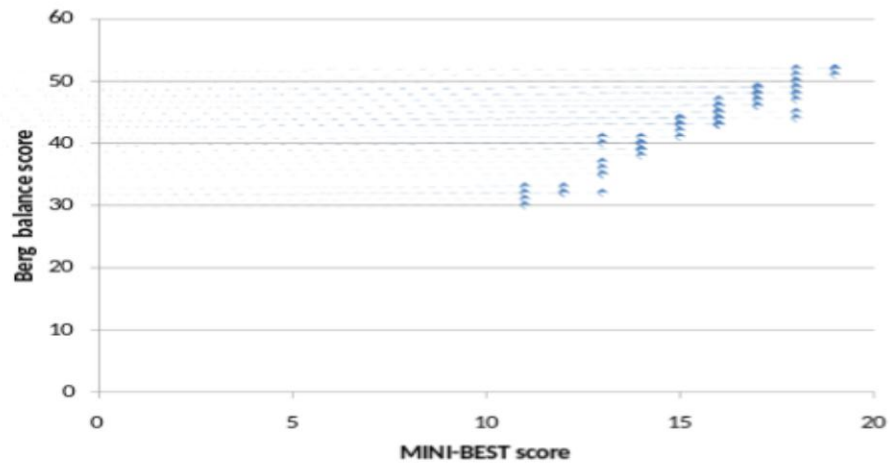


Figure 1:-ROC is done to find optimal cut-off point for Mini-BESTest and BBS based on reference to H&Y classification. The AUC for BBS is 0.993 with 95% CI alongwith 100% sensitivity and 92.3% specificity with criterion >37 for the study population. The AUC for Mini-BESTest is 0.996 with 95% CI alongwith 98.4% sensitivity and 100% specificity with criterion >13.

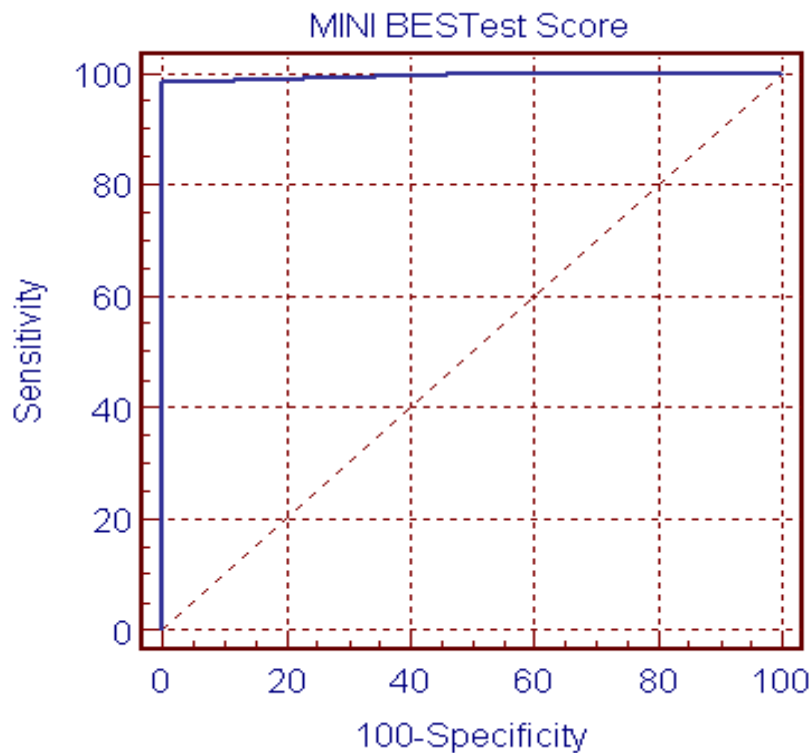


Figure 2

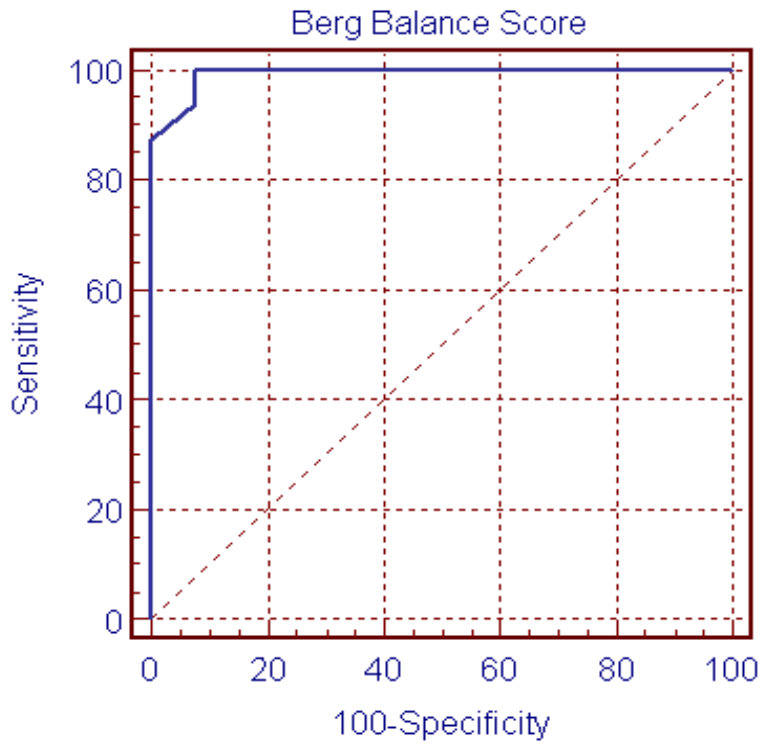


Figure 3

Chart Title

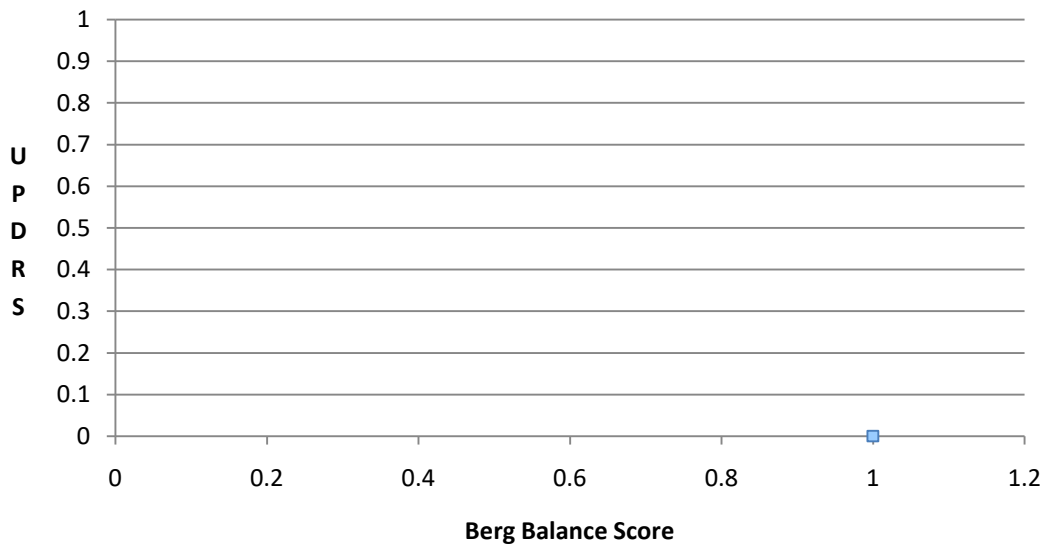


Figure 4

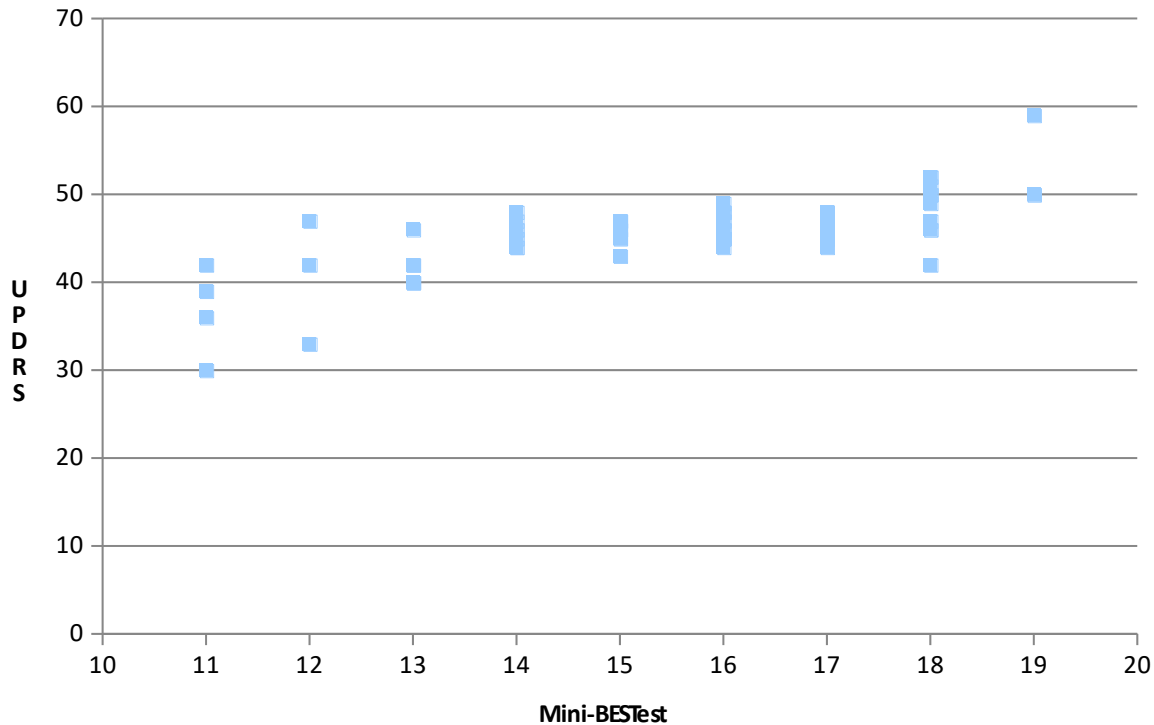


Figure 5

Results:-

The distribution of scores among the 77 participants with PD on the Mini-BESTest differed significantly from the Berg. The Mini-BESTest scores were significantly less skewed than the Berg (Berg skewness = -0.714 versus Mini-BESTest skewness = 0.512 ; $P < 0.001$).

The ability of the Berg and Mini-BESTest was also compared to differentiate PD patients with and without clinical balance deficits. Participants with and without clinical balance deficits were classified using H&Y: H&Y 1-2 and H&Y 3-4. A score of H&Y 3 and 4 identifies people with abnormal postural stepping response to the backwards pull test or observable postural instability. Although, the mean H&Y score was 2.06, the range was 1–4. Roughly one third of the participants had a H&Y of 3 or above, indicating postural instability as defined by H&Y. The area under the ROC curves (AUC) differed for the tests; the AUC for the Berg = 0.993 and the AUC for the Mini-BESTest = 0.996. The 2-sided P -value for testing equality of the two AUC values was 0.05.

Discussion:-

The results from this study suggest that the Mini-BESTest may be more useful than the Berg in evaluating balance disorders in patients with PD, especially in those with mild PD balance deficits. Results show that (1) although the Mini-BESTest had a high correlation with the Berg, it showed different ceiling effects; (2) both the Berg and Mini-BESTest correlated with PD severity (3) the Mini-BESTest test had better sensitivity/specificity than the Berg to identify people with abnormal postural responses. The high correlation of the Mini-BESTest with the Berg supports concurrent validity since the Berg remains one of the most commonly used clinical scales for balance assessment in people with PD. But importantly, it was found during the study that there were very different test score distributions across patients with varied levels of severity. Though neither test had a normal distribution, the Mini-BESTest was significantly less skewed (-0.512), indicating that there are less ceiling effects as has been shown previously with the Berg (-0.714) [30]. The high sensitivity of the Mini-BESTest is important for clinicians who see patients with mild balance deficits who are seeking to identify and treat potentially preventable mobility problems early in the disease progression.

The Berg has been shown to have excellent test-retest reliability³³ and to correlate significantly with disease severity in PD³¹, and the results support the relationship with the UPDRS. Therapists need measures that reflect improvements with intervention so comparing the Mini-BESTest with the UPDRS establishes concurrent validity of the new test with an established one. A previous study demonstrated the Berg to be useful in identifying balance impairments in people with very severe PD (i.e., H&Y 4), but it could not discriminate subgroups of H&Y scores successfully³². In this study, similar results in that the Mini-BESTest was more successful than the Berg at discriminating subgroups of PD severity as measured by the H&Y scale. Franchignoni et al examined the clinimetric properties of the Berg with 57 participants with PD³⁴. They found excellent internal consistency, good correlations to other scales of disease severity, and quality of life, all agreeing with previously published work³⁵.

Rasch analysis was performed on the full BESTest to obtain the shortened Mini-BESTest that excludes redundant or underused items²⁶. Both the Mini-BESTest and the Berg were sensitive (98.4% and 100%, respectively) and specific (100% and 92.3%, respectively) in differentiating those with and without postural response deficits. Similarly, the Mini-BESTest was also shown to be sensitive (88%) and specific (78%) in identifying PD patients with a history of falls³⁶. It has been suggested that postural instability in PD is multifactorial, therefore, a multitude of tests should be administered by physical therapists.^{37,38}

For instance, the Berg does not include tests of postural reactions or dynamic gait, and, therefore, some deficits may be missed. Since the Mini-BESTest is essentially a combination of tests, this may be a reason it successfully identified people with mild balance deficits.

As mentioned in Table 3, each test item primarily tests one of 4 categories of balance: anticipatory, dynamic gait, reactive control, and sensory orientation. The Berg was not designed with such systems in mind but if a system categorization is assigned to each item, the Berg items primarily evaluate anticipatory and sensory contributions to balance.

There are two additional systems that the Mini-BESTest evaluates, dynamic gait, and reactive postural control. This may explain the added variable plot being significant for the Mini-BESTest adding value to the Berg in relating to disease severity. In other words, the Mini-BESTest usefully distinguishes among those persons that are overly range compressed in the Berg. If a clinician is using the Berg for their PD patients, it may be beneficial to augment testing with the Dynamic Gait Index and the Pull test from the UPDRS. Dynamic gait (cognitive task with gait) and reactive postural control (response to perturbation) items were the most difficult items for people with PD, balance systems that are not assessed using the Berg. Clinicians commonly use single-limb stance for balance assessment.

An example of a difference between testing items in the Berg and Mini-BESTest is the assessment of the single limb stance (item #14 Berg, item #3 Mini-BESTest). In the Berg, the participant chooses either leg, and it is only this side that is assessed. Comparatively, the Mini-BESTest assesses both the left and right leg and records the worst side. In this study, when the Berg was used, assessing only one leg, 23.4% of the participants had some observable difficulty. When the Mini-BESTest was used, assessing both left and right leg, 54.5% of the participants had some difficulty. Therefore, clinicians should test standing balance on both sides. This study was limited to people with PD so it needs to be repeated in patients with other pathologies affecting balance control. One potential limitation is that the order of testing was not randomized so fatigue may have factored into test performance. However, participants were given frequent rest breaks to avoid fatigue.

On the other hand difficulty in components of sensory orientation detected that majority of the participants had difficulty in performing those task which was not till date detected by the BBS. Hence this provides an additional advantage to the therapists for their prescription of exercises.

Conclusion:-

Hence we can conclude, Mini-BESTest is useful and easy to administer tool for balance assessment. The Mini-BESTest had a high correlation with the Berg, it had different ceiling effects. Also, Mini-BESTest test had better sensitivity/specificity than the Berg to identify people with abnormal postural responses. Altogether the findings suggest that Mini- BESTest is a promising tool for identifying balance deficits in patients with mild to severe PD.

Limitations:-

Equal distribution of the disease severity could limit the appropriateness of the results.

Future Projection:-

Gender based comparison can be considered in the further studies. A further study can be carried out by compiling equal distribution of the severity of the disease in order to obtain optimum results. Also Physiotherapy intervention can be a part of this study to simultaneously give the benefit to the patient of the treatment as well as the effects of assessment can be observed simultaneously.

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