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The Effect of Body Mass Index on Functional Outcome of Patients with Knee Arthroplasty with and without Hip Abductor Muscle Strengthening: Six Months follow-up of a Randomized Pilot Study

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ABSTRACT

As with aging, the prevalence of knee arthroplasty surgery has increased. Similarly, obesity has also increased parallelly. Many studies have been speculating that abductor muscle strength has more effect on the patients with knee arthroplasty when included in physiotherapy intervention, but no studies demonstrated the influence of BMI (body mass index) on the outcome compared with and without abductor muscle strengthening in physiotherapy intervention. The aim of this study is to investigate the effect of BMI on the physiotherapy interventions with and without hip abductor muscle strengthening. This randomised pilot trial was carried out at Vagdevi College of physiotherapy, Warangal. The study participants are classified for elective TKR (Total Knee Replacement) and were randomised to normal weight group and obese group. All the group subjects underwent FIM (Functional Independent Measure) score, abductor strengthening and six minute walk test at various intervals and followed for six months. All the groups showed improvements in functional outcome irrespective of BMI indicating BMI has minimal effect on the functional outcomes following TKR. The study concludes that hip abductor groups had greater effect on knee function than the standard conventional standard physiotherapy protocol irrespective of BMI effect.

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INTRODUCTION

Osteoarthritis (OA) is a disorder of degradation of cartilage, inflammation of synovial membrane. This leads to the osteophyte formation resulting in the reduction of joint space and finally subchondral sclerosis occurs. (Attur *et al.*, 2013). It is an important cause of disability and theosteoarthritis is the fourth leading and important cause of disability (Rousseau and Garnero, 2012).

OA affects almost all joints of the body and gets affected with OA, but the knee and hip joints are

the most commonly affected than other joints. The prevalence of OA is more among women than men and higher in the elderly population of over 60 years of age (WHO). In the world, one of the most common musculo skeletal disease is osteoarthritis (Felson and Zhang, 1998), and it is one of the most common reasons of joint disability in approximately 100 million people among world having age over 45 years (Hinman *et al.*, 2010).

Europe and USA reported highest world-wide 18% of women and 9.6% of men with symptomatic OA in 60 years and higher age group (Woolf and Pfleger, 2003). Globally Knee OA is 4th most significant cause of incapability in women and men (Azad *et al.*, 2015). The findings of the study done in Asian countries like India, Pakistan, and Bangladesh showed a higher prevalence of OA knee in rural areas and it was found to be 13.7% as compared to 6.9% in urban areas (Fransen *et al.*, 2011).

A study done on the Indian adult population had shown a significant difference in the prevalence of OA between rural (56.6%) and urban areas (32.6%) (Sharma *et al.*, 2007). The risk of knee joint arthritis is more in Asian population compared to American and Europeans. The scan is due to the life style habits (Fransen *et al.*, 2011).

With the aging, the individual joints often deteriorate, with a growing number failing conservative treatment. This may result into surgical intervention. Therefore, with an aging population, the prevalence of joint replacements also continues to increase (Kurtz *et al.*, 2007). OA is strongly associated with aging and Asian countries are aging rapidly. Asian elderly aged $\geq$ 65 years old had increased from 7% in 2008 and is predicted to reach 16% in 2040 (Fransen *et al.*, 2011).The next important risk factor is obesity (Johnson and Hunter, 2014).

Data from the National Health and Nutrition Examination Survey as well as the Framingham Heart Study have found an association between BMI and OA of the knee (Felson, 1988). With obesity there is an increase in the mechanical stress resulting in OA (Cicuttini *et al.*, 1996). Total knee replacement remains as a most effective treatment option (Bade *et al.*, 2010). (Collins *et al.*, 2017) in the study found that patients with BMIs greater than normal can have significant improvements in pain and function after total knee arthroplasty (TKA), including greater improvement in pain and function relative to baseline at 3 months post-operatively versus normal weight patients, and similar improvements from 3 to 24 months.

The subjects who underwent TKR, their lowerlimb function depends upon the hip abductor muscular strength. Hip abductors muscles plays an important role in stabilizing the trunk and hip joint during gait, alignment of limb and transfer of forces from lower limb to the pelvic complex. Hip abductor strengthening has shown reduced pain levels, improvement in physical function and quality of life (Nascimento *et al.*, 2018). Therefore, given that the improvement in patients can be considerable despite their BMI, we have initiated this study to understand the effects of BMI and adductor strengthening on the functional outcome rehabilitation process of TKR in a better way.

MATERIALS AND METHODS

This observer blinded, randomised pilot study was conducted on 40 subjects posted for elective TKR screened for inclusion and exclusion criteria. The study was conducted at Vagdevi College of Physiotherapy, Warangal. The study protocol was approved by the institutional ethical committee.

From all the subjects demographic data such as sex, age, height, weight, duration of hospital stay, discharge summary and previous mobility were obtained before the commencement of study.

The subjects were selected primarily based BMI (body mass index) with age group greater than 50 years diagnosed with unilateral knee osteoarthritis. All the study subjects were evaluated by a single orthopaedic surgeon for diagnosis and staging of knee osteoarthritis. The subjects were excluded from the study if any neurological conditions that interfering with lower limb function, other orthopaedic surgical procedures to the lower extremities.

All the 40 subjects after post TKR status signed an informed consent were randomly assigned to normal weight group and obese group based on their BMI (body mass index. The BMI was calculated for each patient, which is body weight (in kg) divided by height (in m^2). These subjects were then divided into 5 different groups according to BMI as delineated by the WHO. Groups classified by BMI were as follows: (normal weight) 18.5-24.9 kg/m^2, (overweight) 25-29.9 kg/m^2,(class I obesity) 30-34.99 kg/m^2, (class II obesity) 35-39.99kg/m^2, and (class III obesity) 40 kg/m^2.

In the present study the subjects were assigned to 2 groups either to normal weight group(20 subjects) or obese group(20 subjects includes class I,II and II). Further the normal weight group and obese group was sub divided into control (conventional physiotherapy) group and abductor strengthening group

Table 1: Base line characteristics of subjects

Variables	Normal weight group		Obese group		p value
	Control group Mean (SD)	Hip abductor strengthening group Mean (SD)	Control group Mean(SD)	Hip abductor strengthening group Mean(SD)	
Age in years	58.3(5-3)	59.3 (5.4)	57.8 (5.6)	58.9(5.4)	0.862
BMI	23.7(3.3)	23.5 (3.2)	32.8 (3.2)	33.2(3.1)	0.918
Hip Abductor strength in pounds	35.7(6.5)	36.1 (6.0)	35.3 (7.0)	36.9(6.4)	0.537
SMWT in meters	255.4(65.2)	254.1 (79.2)	256.1(64.4)	252(77.9)	0.597
FIM	73	72	72	73	0.0465

Table 2: Between group analysis

Outcome measures	Baseline to 1 month Mean (95% CI)	p value	Baseline to 6 month Mean (95% CI)	p value
Hip Abductor strength in pounds	3.2(.6-5.5)	<0.018	4.2(1.2-6.7)	<0.005
SMWT in meters	20(-29.4-68.3)	<0.410	52.6(-10.4-117.7)	<0.095
FIM	95(90-106.3)	<0.310	110(105-118)	<0.065

Table 3: Knee replacement and body mass index in different groups

	Normal weight		Obese	
	Conservative group	Abductor group	Conservative group	Abductor group
FIM at base line*	74 (61.5, 81.0)	72 (64, 80)	72 (63, 78)	72 (63, 78)
FIM at 6 months*	103 (93.5, 111.5)	108 (101, 112)	108.0(101.5, 113)	109 (102, 111)

*Median (25th and 75th percentiles).

Table 4: FIM score change by BMI

	BMI	FIM overall change*
Normal weight	Conservative group	32 (22, 38)
	Abductor group	33 (29, 41)
Obese	Conservative group	32 (22, 38)
	Abductor group	34 (29, 42)

*Median (25th and 75th percentiles)

with each 10 subjects in a group by convenient sampling method.

All the subjects in the conventional group underwent a standard physiotherapy programme from day of surgery until discharge and follow-up management which included (phase 1 exercises: ankle exercises, quadriceps isometrics, gait training with walker, bed mobility, hip flexion with knee extension, active assisted, active knee ROM exercises, progression of exercises to the subjects pain tolerance, 1-3 sets of 10 repetitions for all exercises (phase II exercises; knee active rom in supine or sitting positions, gait training, activities of daily living traing, balance training and functional training like sit to stand etc.(phase III: specific strengthening exercises with added weight 1-2 kg in supine or sitting, multiple angle knee isometric exercises and dynamic exercises.) in addition to these exercises abductor strengthening exercise group was given abductor specific strengthening exercises in progressive manner like abduction in side lying position and standing, abductor isometric exrcises, abductor

calm exercises, side walking and progression with weight cuffs and Thera band.

The functional outcome was assessed after surgery and at 1 month and 6 months following TKR, using 1) FIM, The 18-item(FIM) measure assesses 5 cognitive and 13 motor function items, with each item score on a scale of 1-7. A score of 1 indicates a need of total assistance, and a score of 7 indicates total independence. 13 Overall, FIM gains were calculated by summing the motor and cognitive FIM scores. 2) six minute walk test: The six minute walk test (SMWT) assesses the physical function by totalling the distance covered maximally by the participant walking at their free speed on a measured 46 meter uncarpeted rectangular indoor area during the 6-minute duration. The participants walked as much distance as possible with an assistive device if required and the distance covered was measured to the nearest meter. 3) Hip abductor strength: the subjects hip abductor strength was measured by using hand held dynamometer in supine lying position with proper verbal commands to isometric ally contract hip abductors for 5 sec by placing the dynamometer above the knee joint line and strength was quantified in pounds. A blind observer with more than 10 years of clinical physiotherapy experience collected the data from outcome measures (Table 1).

RESULTS AND DISCUSSION

SPSS software (version 20.0) was used for statistical analysis. ANOVA was used to find out the effects of standard physiotherapy protocol and effects of hip abductor muscle strengthening at base line, 1 month and 6 months follow up respectively. Post-hoc test was sued for pairwise comparisons. Linear regression analysis of FIM score was performed with BMI categories. All statistical analysis were 2-sided and p value 0.05 was considered statistically significant.

There is no significant change in the rate of recovery after knee replacement surgery following physiotherapy protocol in all the four groups. The study found good similar recovery in obese group with no marked difference in rate of recovery between all the groups (Table 2). This implies that BMI does not affect the rate of recovery following physiotherapy management post knee surgery.

A study conducted to compare the acute recovery during hospitalisation in both normal and obese patients affected with cardiovascular disease, pulmonary disease, traumatic brain injury, and in those hospitalized for amputation. Acute findings were marginally better but no statistical significant recovery was observed during hospitalization of overweight as compared to normal weight patients (Burke *et al.*, 2014, 2019a).

A study was conducted by targeting the effect of functional rehabilitation in improving the physical performance post TKR. Subjects walked 145 meters lesser at 12 months duration in SMWT following TKR (Moffet *et al.*, 2004). (Petterson *et al.*, 2009) conveyed a similar study and found that the study patients walked 150 meters further 12 months post-operatively.

A study was conducted to find the effects of hip abductor strengthening on physical performance following knee surgery. The participants in the HAS group walked faster and longer than the KS participants at 1 year. The HAS group walked additional 132 meters at 3 months, 219 meters at 1 year and the KS group walked 118 meters more at 3 months and 179 meters at 1 year. The group's analysis has shown a significant difference at 1 year with a mean difference of 88.3 meters.

Present study concentrated on the effects of hip abductor strengthening on physical performance and BMI. Six minute walk test score for the 4 groups: normal abductor group scores at base line, 1 month, 6 months respectively are (254,306,404), normal control group (255,304,400), and obese abductor group (252,304,402) obese control group (256,305,400s). From the above values it is evident that walking performance had improved in both normal and obese abductor group.

By comparing between the previous studies conducted by moffet et al., Peterson et al., and karvannan harikesavanet al., it is evident that abductor strengthening group showed maximum improvement in physical performance. This suggests the importance of abductor strengthening post TKR. The previous study results are correlating with present study results.

From the present study it also implies that BMI does not affect the rate of recovery with proper targeted rehabilitation following surgery. It can also be theorized that it is the strength effecting the physical performance but not the BMI. From the above studies it can also be advocated that though there may be slow recovery acutely but there are no changes in the rate of recovery in long term.

Hip abductor strength

In the previous study, the abductor muscle strength at baseline and 1 year for the experimental group are 36+-6.0 and 45.7+-6.7 and for the control group are 36+-7 and 39.8+-6.2 respectively. The difference in the experimental group and control group at 1 year are 9.7 and 3.8 respectively (Harikesavan *et al.*,

2017).

In Present study abductor strength for the four groups are: Abductor strength at base line 1 month and 6 months for the normal abductor group are (36,40,43), normal weight control group (32,34,36), obese abductor group (36,38,41), obese control group (32,34,35). From the above values it is evident that normal and obese abductor group showed maximum improvement in abductor strength.

BMI is considered to be one of the most important factor. Generally, obese individuals require more torque of hip abductors compared to normal weight individuals. This advocates that obese individuals are at disadvantage for gaining appropriate muscle strength.

From the above values it is evident that hip abductor strength improved in normal and obese abductor group. From the above studies it is also clearly understood that physical performance has been improved in the normal as well as obese abductor group. Comparing both the statements it can proposed that improvement in the physical performance of obese and normal abductor group could be due abductor strengtheningand also implies that physical performance does not depend on the BMI when a targeted rehabilitation is followed.

Fim Scores

FIM scores of the present study at baseline, 1 month, and 6 months for the normal weight abductor group are (72,90,108) respectively, normal weight conservative group (73,92,104), obese abductor group (73,92,106), obese conservative group(72,90,104) (Tables 3 and 4).

A conducted a study on The Effect of Body Mass Index on Functional Outcome of Patients With Knee Replacement the FIM scores at the time of discharge improved from 74-108 for normal weight individuals, for overweight 74-108, obese class 1 69-109, for obese class ii 68-108, for obese class iii 65-108. There is not much difference in scores between the groups (Burke *et al.*, 2019a). The above values are correlating with the present study results. So it can be implied that raised BMI is not the factor for rejection of patients for surgery.

Earlier study concluded that there is not much difference in knee society functional scores post operatively between obese and normal groups. But oxford knee score (OKS) and mental component scores (MCS) showed smaller improvements in obese people compared to normal weight people (Xu *et al.*, 2018).

Generally one may expect negative effects when considering the provided medical complications about the effects of obesity in health status and prognosis of a condition. In some cases surgery is rejected keeping in mind about the negative impact of obesity like duration of surgery, increased risk of infection, elevated levels of blood loss, duration of hospital stay and response to exercises etc. because of such reasons surgery is postponed till the weight reduction is achieved. The guidelines of American academy of orthopaedic surgeons and United Kingdom National Health Service suggest caution and rejection of surgery should be based on BMI (Burke *et al.*, 2019b).

Generally, obesity appears to be a reasonable hint for poor health indicating that surgery may increase the risk, resulting in a poor outcome post-surgery. However, our study results are in opposite to the previous data. The present study results are in line with previous literature assessing the relation between post-surgical complications and obesity. Confounding variables like comorbidities that are present in obese people may be the strong reason for adverse effects and as such BMI is not major risk factor for fast recovery following physiotherapy protocols.

CONCLUSIONS

The study on post TKR rehabilitation found that, compared to normal weight group, the functional improvement in obese group also yielded good results indicating rate of recovery similar in all the four physiotherapy groups irrespective of their BMI.

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