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Introduction:

Osteoarthritis (OA) results in disability and loss of function that affects a person's ability to perform activities of daily living (ADL) [1]. There is no current cure for OA and the end-stage treatment is Total Knee Arthroplasty (TKA). This surgery has become more prevalent throughout the United States over the past decade, with an estimated 3.48 million surgeries to be performed by the year 2030[2]. Current literature reports that after replacements individuals show improvements in physical function and self-reported pain levels. However, there are conflicting findings regarding the change in physical activity levels after TKA. According to the Center for Disease Control and Prevention, regular physical activity may produce long-term health benefits and improve health for older individuals with diseases and/or disabilities. Specifically, engaging in 150 minutes of moderate-to-vigorous intensity aerobic activity each week has been shown to result in long-term health benefits [3].

Evidence suggests that on average, patients do not adopt an active lifestyle 6 months after TKA surgery. Although, patients do have improvements of clinical functional measures, such as the 6-minute walk test; sit to stand task, and stair climbing tasks [4]. Previous measures on physical activity include questionnaires that ask questions regarding the number of steps taken per day and level of participation in sports or activities. Using these measures has not lead to a clear understanding of the change in patient activity levels after TKA, current work has begun to use accelerometers to test multiple aspects of activity. One study found that physical activity after TKA either remained the same or slightly decreased 6 months after surgery when assessed with an accelerometer [5]. Although literature has shown no improvements in physical activity up to 6 months after surgery there is limited evidence regarding the levels of moderate-to-vigorous physical activity (MVPA) performed after TKA. The purpose of this study is to describe the changes in physical function and changes in time spent in MVPA in order to determine if an association exists between physical function and MVPA. We hypothesized that patients with the better physical function will spend more time in MVPA.

Materials and Methods:

Recruitment:

The data shown in this study was collected from the Center for Advanced Joint Replacement at Christiana Care Health Systems. Patients who participated in the study met the following inclusion criteria: had end-stage knee osteoarthritis, were scheduled to undergo a primary total knee replacement. Patients were excluded if 1) had a neurological disease effecting their ability to walk one city block, 2) any loss of sensation in the lower extremity that results in difficulty ambulation 3) had OA in the contralateral knee requiring surgery within 6 months 4) had a revision during the process of the study. A written consent was obtained from all participants in accordance with the University of Delaware and Christiana Care IRB.

Subjects:

Forty-five patients who underwent TKA between May 2015 and February 2017 were recruited and prospectively followed throughout the study. The average age of the participants during the course of the study was approximately 65 ± 7 years and BMI was 32.5± 7.5 kg/m^2.

Physical Activity Measurements:

Moderate-to-vigorous physical activity (MVPA): Time spent in MVPA was quantified using minutes spent in ≥ 2020 activity counts during valid wear days, which was measured using a uniaxial accelerometer (Actigraph GT1M, Pensacola, FL, USA). The Actigraph GT1M is a valid device to quantify physical activity in free-living conditions[6]. Patients were fitted with the accelerometer above the right hip and were instructed to wear the accelerometer during waking hours for 7 consecutive days. Briefly, we defined a valid wear day as ≥ 10 hours of wear time and included participants with ≥ 4 valid wear days, as this is the minimum time needed for a reliable estimate of physical activity behavior.

Clinical Functional Measures:

All functional measures were obtained at the pre-operative and post-operative visit and are as follows: 1) Six-minute walk test (6-MWT): The 6-MWT is a sub-maximal exercise assessment that measures the distance a patient walks in 6-minutes [7]. The 6-MWT was performed indoors on a continuous track that had cones placed at four corners to guide the patients where to walk. Prior to the test, the patient was given verbal instructions to walk as quickly and safely as possible but as to not over-exert themselves. The patient was permitted to stop during the but were also informed the time would continue to count down. The patient was informed when there were 4 minutes, 2 minutes, and 1 minute left in the test. The research tracked the distance the patient walked over 6 minutes using a wheel to mark the distance in feet. At the conclusion of the test, the distance covered in feet was recorded. The 6-MWT has been validated and has a good test reliability [8].

2) 30-second chair stand test (30-CST): The patient was asked to come to a complete sit and stand as many times as possible in the 30-seconds while keeping their arms crossed across their chest. The 30-CST test is correlated with lower extremity functional strength [9]. The number of stands completed was recorded. This test has been validated and has good test-reliability [10].

3) Timed Up and Go Test (TUG): The TUG test measures the time it takes to rise from a chair walk 3-meters and return to sit [11] and correlates to the risk of falls and patient balance. The patient was instructed to rise from a chair without the use of the armrests and move as quickly and safely as possible to a mark on the ground (designating 3m). They were asked to cross that mark with both feet and then move as quickly as they felt safe and comfortable back to the chair and return to siting. The arms of the chair were permitted to be used if necessary and this was documented. Time starts when the research says "Go" and stops once the back of the patient touches the back of the chair. Two trials were performed and recorded in seconds, and the

average of the two trials was reported. The Timed Up and Go Test has been validated and has good test-reliability [12].

Statistical Analysis:

The study sample is described using means and standard deviations for continuous variables and percentages for categorical variables. Post-operative functional scores where subtracted from pre-operative scores to calculate change scores over time. The normality assumptions where checked for each variable. Since the data was not normally distributed non-parametric tests were performed. To examine the association of time spent in MVPA with the physical function, Spearman correlation were performed. In order to compare 2 parametric groups, a two tailed Student t test was used. For statistical analysis, the computer software SPSS V20.0 was used.

Results:

The strength of the relationship between the change in MVPA and the change in the three functional measures were formulated and presented in Table 1. In addition, the means and standard deviations of MVPA, the functional tests, age, and BMI were recorded at pre-operative and 6-months post-operative time points and reported in Table 1.

Pre TKR:
Time spent in MVPA pre-TKR had a small negative correlation with age ($r=-0.28$, $p = 0.069$) and BMI ($r=-0.215$, $p=0.183$). Time spend in MVPA pre -KR had small to moderate positive relation with physical function test 6-MWT pre-TKR ($r=0.4$, $p<0.001$), 30-CST pre-TKR ($r=0.306$, $p=0.055$), and TUG pre-TKR ($r=0.33$, $p=0.03$).

Post TKR:

Time spent in MVPA post-TKR had a small negative correlation with age ($r=-0.28$, $p=0.062$) and BMI ($r=-0.326$, $p=0.033$). Time spent in MVPA post-TKR had moderate positive relation with physical function test 6-MWT post-TKR ($r=0.54$, $p=0$), 30-CST post-TKR ($r=0.48$, $p=0.001$), and a moderate negative correlation with TUG post-TKR ($r=-0.63$, $p=0$).

Change from Pre-operative to Post-operative

Change in MVPA had a small negative correlation with physical function test Δ 6-MWT ($r=-0.12$, $p=0.49$), 30-CST ($r= -0.015$, $p= 0.93$), and a small positive correlation with Δ TUG ($r= 0.14$, $p= 0.41$).

Table 1. Descriptive Statistics and Change scores of functional measures and associations between MVPA and the functional tests

Measure	Time Point	Mean	StDev	Correlation	P-Value
MVPA (minutes)	Pre	8.8	9.9		
	Post	11.6	15.2		
	Δ	2.8	14.4		
TUG (sec)	Pre	8.55	2.5	-.330*	0.035
	Post	7.51	1.77	-.632*	0.000
	Δ	-1.13	1.66	0.137	0.406
6MWT (feet)	Pre	1466	320	0.299	0.058
	Post	1705	355	0.536*	0.000
	Δ	209	188	-0.119	0.489
30-CST (sec)	Pre	12	3	0.306	0.055
	Post	15	4	0.484*	0.001
	Δ	2	3	-0.015	0.928
Age (years)	Pre	65	7.3	-0.287	0.069
	Post	65	7.2	-0.287	0.062
BMI (kg/m^2)	Pre	32.9	6.6	-0.215	0.183
	Post	32.5	7.5	-.326*	0.033

*Denotes statistical significance pvalue <0.05

Discussion:

We examined the relationship between MPVA and the 3 functional measures (TUG, 30-CST, 6MWT) and 2 clinical measures (Age, BMI) at pre and 6-months post-TKR as well as the relationship between the change in MVPA and change in physical function assessments from pre to 6 months post-TKR. We hypothesized that individuals with better functional performances would spend more time in MVPA. However, our results did not support our hypothesis as physical function and MVPA were not strongly correlated. This suggests these three common physical function measures, alone are not very good indicators of time spent in MVPA. Age and BMI where not statistically correlated to MVPA at pre-op and post-op time points.

At the pre time point, MVPA was weakly correlated with all five variables. The strongest correlation coefficient was a value of -0.33 between MVPA and TUG, although statistically significant this value marks a weak relationship. At the 6 months post op time point, MVPA was weakly to moderately correlated with all five variables except for the TUG test. At pre and 6 months post op, our data show that at most, a small to moderate correlation exists between the clinical variables and MVPA.

In addition, we calculated change scores for MVPA, 6-MWT, 30-CST, and TUG. There was no statistically significant relationship between the change scores for MVPA and the three functional measures.

Functional measures are not related to MVPA. The reasoning behind this is likely due to a distinction in the characteristics between MVPA and the functional tests that were performed. Different requirements must be met to perform moderate to vigorous activities compared to a test such TUG and 30-CST. When engaging in activities that are moderate to vigorous, you put maximal stress on the cardiovascular system. This includes a sharp increase in heart rate in order to meet the increasing demands of the working muscles, which need adequate levels of oxygen to perform. A few of these activities may include but are not limited to walking briskly, general gardening, bicycling, playing tennis, and jumping rope. On the contrary, functional tests such as TUG and 30-CST, assess static/dynamic balance and lower limb strength. These assessments are testing completely different aspects of function compared to what MVPA requires. Therefore, it is reasonable to conclude that one's strong performance on a functional test may not necessarily render high amounts of MVPA and vice versa. This is supported by the weak relationships that were seen between MVPA and the functional measures in our data.

All of the change correlation coefficients between MVPA and the functional measures all represented very weak correlations. From the data, we saw that most individuals did not increase physical activity levels from pre to 6 months post op. Those who did increase MVPA did so slightly. However, we did see some of these individuals achieve better scores on the functional tests, further stressing the idea that there is not a strong correlation between one's change in MVPA and one's change in his or her functional performance. Six months after TKR, on average, individuals are still experiencing some discomfort while also trying to become acclimated to their new, artificial joint. After replacement, a small percentage of patients actually return to sports or high level activates they participated in before surgery[13]. Although they may have low moderate-to-vigorous activity levels, they may be capable of performing exceptionally well on measures such as the 6-MWT. Again, the functional measures test different capacities and systems of the body and the requirements are not merely the same.

A limitation of this study is that the sample size was rather small. With a sample of 42 people, there is a possibility that not all TKA patients are represented in this sample. In the future, adding more members of the population to this sample will give us more confidence with the results of our data. Another potential limitation is that we did not control for confounding variables such as previous physical activity history or psychological factors such as depression. Despite these limitation, our study had several strengths. First, we used an objective measure of physical activity. Time spent in MVPA captures all the activities that people with OA get involved in, which burn off three to six times as much energy per minute as they would do when they are sitting quietly. Since people with knee OA often engage in a non-stepping physical activity such as gardening, house cleaning etc. that produces lower or no steps, time spent in MVPA gives the an more accurate represenation of their physical activity.

Conclusion:

This study provided insight on the relationship that exists between age, BMI, physical function measures and MVPA. Our results revealed that there is a weak correlation between physical function and MVPA at pre-op and 6 months post op. In addition, the change in MVPA and change in physical function was also weakly related. Further exploration into physical activity and physical function is needed to solidify our understanding of this topic and for the betterment of individuals undergoing TKA. These results raise to question the current interventions used in the clinic during physical therapy rehabilitation that directly target improvements in physical activity vs physical function. Current clinical interventions may be excellent at improving patient function but are not targeted enough to directly affect patient physical activity. This study also supports the need for improved measures that are clinically applicable to better report physical activity and MVPA as current functional measures do not correlate with patients' physical activity.

References

1. Hunter DJ, Felson DT. Osteoarthritis. *BMJ*. 2006;332(7542):639-642. doi:10.1136/bmj.332.7542.639.

2. Stenquist DS, Elman SA, Davis AM, et al. Physical Activity and Experience of Total Knee Replacement in Patients One to Four Years Postsurgery in the Dominican Republic: A Qualitative Study. *Arthritis Care Res (Hoboken)*. 2015;67(1):65-73. doi:10.1002/acr.22367.
3. Prevention, C. for D. C. and. (2016). Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Retrieved from http://webappa.cdc.gov/sasweb/ncipc/nfilead2001.html
4. Dominick GM, Zeni JA, White DK. Association of Psychosocial Factors With Physical Activity and Function After Total Knee Replacement: An Exploratory Study. *Arch Phys Med Rehabil*. 2016;97(9):S218-S225. doi:10.1016/j.apmr.2015.09.028.
5. De Groot IB, Bussmann HJ, Stam HJ, Verhaar JA. Small increase of actual physical activity 6 months after total hip or knee arthroplasty. *Clin Orthop Relat Res*. 2008;466(9):2201-2208. doi:10.1007/s11999-008-0315-3.
6. Stenquist DS, Elman SA, Davis AM, Bogart LM, Brownlee SA, Sanchez ES, et al. Physical Activity and Experience of Total Knee Replacement in Patients One to Four Years Postsurgery in the Dominican Republic: A Qualitative Study. Arthritis Care Res (Hoboken). 2015;67(1):65–73.
7. Six-Minute Walk Test. (n.d.). Retrieved August 07, 2017, from http://pulmonaryrehab.com.au/patient-assessment/assessing-exercise-capacity/six-minute-walk-test
8. The 6-minute walk test in outpatient cardiac rehabilitation: validity, reliability and responsiveness-a systematic review. (n.d.). Retrieved August 07, 2017, from http://www.sciencedirect.com/science/article/pii/S0031940612000223?via%3Dihub
9. https://www.cdc.gov/steadi/pdf/30_second_chair_stand_test-a.pdf
10. Unver, B., Kalkan, S., Yuksel, E., Kahraman, T., & Karatosun, V. (2015). Reliability of the 50-foot walk test and 30-sec chair stand test in total knee arthroplasty. *Acta Ortopedica Brasileira*, *23*(4), 184–187. http://doi.org/10.1590/1413-78522015230401018
11. Podsiadlo, D. and Richardson, S. (1991), The Timed “Up & Go”: A Test of Basic Functional Mobility for Frail Elderly Persons. Journal of the American Geriatrics Society, 39: 142–148. doi:10.1111/j.1532-5415.1991.tb01616.x
12. Podsiadlo, D., & Richardson, S. (1991, February). The timed "Up & Go": a test of basic functional mobility for frail elderly persons. Retrieved August 08, 2017, from https://www.ncbi.nlm.nih.gov/pubmed/1991946
13. Witjes S, Gouttebarge V, Kuijer PPFM, van Geenen RCI, Poolman RW, Kerkhoffs GMMJ. Return to Sports and Physical Activity After Total and Unicondylar Knee Arthroplasty: A Systematic Review and Meta-Analysis. Sport Med. Springer International Publishing; 2016;46(2):269–92.
14. Delasotta LA, Rangavajjula A V, Porat MD, Frank ML, Orozco FR, Ong AC. What are young patients doing after hip reconstruction? J Arthroplasty [Internet]. Elsevier Inc.; 2012;27(8):1518–1525.e2. Available from: http://www.sciencedirect.com/science/article/pii/S0883540312000861