Internet Journal of Allied Health Sciences and Practice

Volume 20 | Number 3 Article 9

June 2022

State-Trait Anxiety and the Relationship with Patient Outcomes Following TKA

Alma K. Crouch
Campbell University, akcouch1016@email.campbell.edu

Jennifer Bunn
Sam Houston State University, jab229@shsu.edu

Michelle Green
Campbell University, mgreen@campbell.edu

Recommended Citation

Crouch AK, Bunn J, Green M. State-Trait Anxiety and the Relationship with Patient Outcomes Following TKA. The Internet Journal of Allied Health Sciences and Practice. 2022 Jun 29;20(3), Article 9.

State-Trait Anxiety and the Relationship with Patient Outcomes Following TKA

Abstract

Purpose: To analyze the relationships between state (S) and trait (T) anxiety and functional outcome measure performance in patients following total knee arthroplasty (TKA) receiving physical therapy (PT). **Methods:** Nineteen patients (62.7±9.9 years) who recently underwent TKA completed testing post-TKA and at discharge that included the modified Lower Extremity Functional Scale (mLEFS), Numeric Pain Rating Scale (NPRS), State-Trait Anxiety Inventory (STAI), Pain Catastrophizing Questionnaire (PCQ), knee range of motion (ROM), thirty-second chair stand test (30s-CST), and the timed up and go (TUG) test. Additionally, NPRS, ROM, 30s-CST, and TUG measures were taken at three and five weeks following TKA. **Results:** Baseline S- and T-anxiety correlated highly with baseline PCQ (ρ= .546-.676, p= .001-.016) and the 30s-CST (S-Anxiety ρ= -0.531, p= .019). Baseline S- and T-anxiety revealed strong correlations with discharge PCQ scores (S-anxiety ρ= .462-.536, p= .018-.046). The discharge S- and T-anxiety surveys also correlated with discharge measures of mLEFS (ρ= .606-.675, p= .002-.006) and NPRS (ρ= .588-.707, p= .001-.008). **Conclusions and Recommendations:** This study of S- and T-anxiety and its effects on outcomes following TKA procedures revealed patients' pain, ROM, and functional outcome measures improved, while S-anxiety, T-anxiety, and PCQ scores had no significant changes from baseline to discharge. Knowing this, clinicians could be proactive and incorporate relaxation techniques, stretching, and massage as a standard means of care.

Author Bio(s)

Alma Kathryn Crouch, PT, DPT is an acute care Physical Therapist at Vidant Medical Center in Greenville, NC. She graduated from Campbell University's Doctor of Physical Therapy program in December 2020 where the research for this article was first instituted.

Jennifer Bunn, PhD is the Associate Dean for the College of Health Sciences at Sam Houston State University and a Fellow of the American College of Sports Medicine (ACSM).

Michelle Green, PT, DPT, c-NDT, NCS is an Assistance Professor for the College of Pharmacy and Health Sciences at Campbell University's Doctor of Physical Therapy school. Dr. Green is also a practicing American Physical Therapy Association (APTA) neurological certified specialist in the state of North Carolina.

IJAHSP™
The Internet Journal of Allied Health Sciences and Practice
Dedicated to allied health professional practice and education
Vol. 20 No. 3 ISSN 1540-580X

State-Trait Anxiety and the Relationship with Patient Outcomes Following TKA

Alma K. Crouch
Jennifer Bunn
Michelle Green

1. Campbell University
2. Sam Houston State University

United States

ABSTRACT
Purpose: To analyze the relationships between state (S) and trait (T) anxiety and functional outcome measure performance in patients following total knee arthroplasty (TKA) receiving physical therapy (PT). **Methods:** Nineteen patients (62.7±9.9 years) who recently underwent TKA completed testing post-TKA and at discharge that included the modified Lower Extremity Functional Scale (mLEFS), Numeric Pain Rating Scale (NPRS), State-Trait Anxiety Inventory (STAI), Pain Catastrophizing Questionnaire (PCQ), knee range of motion (ROM), thirty-second chair stand test (30s-CST), and the timed up and go (TUG) test. Additionally, NPRS, ROM, 30s-CST, and TUG measures were taken at three and five weeks following TKA. **Results:** Baseline S- and T-anxiety correlated highly with baseline PCQ (ρ= .546-.676, p= .001-.016) and the 30s-CST (S-Anxiety ρ= -0.531, p= .019). Baseline S- and T-anxiety revealed strong correlations with discharge PCQ scores (S-anxiety ρ= .462-.536, p= .018-.046). The discharge S- and T-anxiety surveys also correlated with discharge measures of mLEFS (ρ= .606-.675, p= .002-.006) and NPRS (ρ= .588-.707, p= .001-.008). **Conclusions and Recommendations:** This study of S- and T-anxiety and its effects on outcomes following TKA procedures revealed patients' pain, ROM, and functional outcome measures improved, while S-anxiety, T-anxiety, and PCQ scores had no significant changes from baseline to discharge. Knowing this, clinicians could be proactive and incorporate relaxation techniques, stretching, and massage as a standard means of care.

Keywords: Anxiety, Functional Outcomes, Pain, Psychological factors

CONFLICTS OF INTEREST: None declared
FUNDING SOURCE: None declared

INTRODUCTION

Total knee arthroplasty (TKA) is a routine surgical procedure for individuals experiencing pain and activity limitations secondary to severe osteoarthritis (OA).[1-5] As this procedure has become common, research studies have investigated the predictive factors—physical characteristics and psychological influences—affecting outcomes following TKAs.[3,4,6]

Anxiety is a reaction to fear characterized by disturbances in mood and conflicts with thinking and behavior.[7] It can be divided into two subgroups: trait (T) anxiety and state (S) anxiety.[8] T-anxiety refers to perceiving situations with increased stress, apprehension, and worry.[7,8] S-anxiety refers to a transitory emotional response to specific situations at a specific time, characterized by increased sympathetic nervous system responses including increased heart rate, sweating, breathing and muscle tension.[7,8] T-anxiety is a chronic state, while S-anxiety presents acutely and specific to a current situation. Individuals with higher T-anxiety have increased S-anxiety reactions; however, S-anxiety can fluctuate based on the situation and individual perception.[7,8]

Studies of mental health and its effects on pain have revealed lower pre-operative mental health scores are strongly related to increased pain post-operatively in patients undergoing TKA.[4] Anxiety is prevalent in patients with OA where 25 – 40% of patients with a diagnosis of OA also reported anxiety as a comorbidity.[9] People with S-anxiety, as opposed to T-anxiety, experience higher pain levels in this population and report overall less satisfactory following their procedures.[9] S-anxiety, independent of depression, was shown to contribute to 27% of the variance in pain in elderly patients and was the only predictor of acute pain following orthopedic surgery.[10] Pain catastrophizing has been linked to anxiety and pain in patients with OA following TKA[5,11], and has been identified as the only predominant predictor of negative outcomes following TKA.[5] Further review identified female gender, age <60 years at surgery, heightened depression, anxiety, and pain catastrophizing as significant factors contributing to increased pain following TKA.[5]

There is little evidence regarding the relationship between S and T anxiety and performance-based clinical outcome measures for physical function in patients following TKA. Previous studies have analyzed the effects of generalized anxiety on perceived function, daily activity, psychosocial measures, and gender differences regarding pain following TKA. Such studies indicate no difference between psychosocial scores or accelerometry (movement measured through a wearable device) for males and females' pain and function prior to TKA.[1] Psychosocial measures, objective measures of mental health, such as pain catastrophizing and increased anxiety scores have been shown to affect functional status for males and females. However, regardless of gender, S-anxiety is a predictor of activity tolerance in patients with severe OA. S anxiety may be an important metric with patients undergoing surgery, as there may be fluctuations in one's anxiety state. T-anxiety is the strongest predictor of perceived functional outcomes in patients following TKA.[2] These studies all utilized accelerometry and self-reported daily activity levels to measure functional outcomes.

Performance-based outcome measures are designed to objectively measure a set of movements or tasks. They are crucial for evaluating a patients' functional status, allowing physical therapists to identify impairments and limitations in activities which enhance the development of interventions specific to the patient's needs. The 30-second chair test (30-sCST) and timed up and go (TUG) test were identified by the Osteoarthritis Research Society International to be among the preferred performance-based outcome measures to capture physical function in research and clinical practice.[12] No previous literature evaluating anxiety in patients' status-post TKA included these measures. The purpose of this study was to analyze relationships between S- and T-anxiety and functional outcome measures [self-reported pain, range of motion (ROM), 30s-CST and TUG] in patients following TKA and physical therapy. This will be the first study to evaluate the relationship between S and T anxiety with functional outcome measures in patients post-TKA. Investigators hypothesized that increased measures of S-anxiety at baseline would correlate with increased pain and decreased ROM, 30s-CST, and TUG results at baseline and discharge.

METHODS

Participants and Study Design

This was a longitudinal observational study design. Participants were recruited from July 2019 – February 2020 from an outpatient physical therapy clinic. A sample size of 19 was calculated to achieve 80% power based upon the 30s-CST outcome measure. Eligibility criteria for study participation included community dwelling adults 18 years of age or older who underwent TKA surgery within the previous week. Participants were excluded if they had a previous history of dementia. All participants were provided informed consent and points of contact for questions or concerns. This study was approved by an institutional review board and conducted in compliance with the Declaration of Helsinki.

All participants received physical therapy (PT) interventions through Pinnacle Orthopedics. Services were guided by a physical therapist under the scope of their professional license. Patients were seen in clinic 2-3 times a week for 6-8 weeks contingent upon individual progress. A physical therapist provided skills aligned with the standard of care for post-op TKA and included both in-person and home-based interventions prescribed for each individual participant to maximize overall patient outcomes.

Table 1 indicates measures completed at each time point. Baseline measures were taken one week following each participant's date of surgery. ROM, 30s-CST, and TUG measures were collected at weeks three and five. Final assessments were completed at week seven or upon discharge from physical therapy.

Table 1. Timeline of tests and measures throughout the study duration. Measurements are aligned to show the frequency of repetition throughout the study.

Baseline (1 week post-op)	3 weeks post-op	5 weeks post-op	Discharge
Routine intake form			
Informed consent			
Medical history			
STAI			STAI
mLEFS			mLEFS
NPRS	NPRS	NPRS	NPRS
PCQ			PCQ
AROM	AROM	AROM	AROM
PROM	PROM	PROM	PROM
30-sec CST	30-sec CST	30-sec CST	30-sec CST
TUG	TUG	TUG	TUG

Notes: State-Trait Anxiety Inventory (STAI), modified Lower Extremity Functional Scale (mLEFS), Numeric Pain Rating Scale (NPRS), Pain Catastrophizing Questionnaire (PCQ), active range of motion (AROM), passive range of motion (PROM), thirty-second chair stand test (30s-CST), and the timed up and go (TUG)

Measures

The State-Trait Anxiety Inventory (STAI) is a patient-reported 40-item questionnaire examining both S- and T-anxiety. Items are scored on a 4-point Likert scale with a subsequent scoring reference used to calculate a total. Higher scores indicate increased presence of S- and T- anxiety. Test-retest reliability for the T-anxiety form is 0.765.[13] The S-anxiety form was lower with a median coefficient of 0.33, which is to be expected of a measure of situational stressors.[13] Cronbach's alpha (α) for S-anxiety and T-anxiety are 0.92 and 0.90, respectively, indicative of good internal consistency.[13] The STAI has also been tested and shown good construct validity.[13] The Pain Catastrophizing Questionnaire (PCQ) is a patient-reported 13-item questionnaire that assesses one's attitude towards noxious stimulus. Items are scored on a 5-point Likert scale with higher scores indicating a more negative outlook on pain. The test shows good concurrent validity with a previously validated scale, and acceptable internal consistency (α = 0.87).[11] The PCQ has a minimal clinically important difference (MCID) of 6.48.[14]

The modified version of the Lower Extremity Functional Scale (mLEFS) is a self-reported questionnaire used to assess perception of function. It contains ten items assessing the patient's difficulty performing activities of daily living. A higher score indicates a more severe disability. Test-retest for the original LEFS in patients that had undergone TKA demonstrated good validity and reliability with a calculated intraclass correlation coefficient (ICC) of 0.85.[15] The mLEFS was chosen over the original version due to the reduced number of questions and thus the overall reduced time for participants in completing surveys. Chronbach's α for baseline (α = .748) and discharge mLEFS scores (α = .869) showed acceptable internal consistency. Participants also completed the Numerical Pain Rating Scale (NPRS), which is a numeric rating of pain intensity from 0-10. A higher score is indicative of increased pain. This test demonstrates good test-retest reliability and high construct validity in comparison to the visual analog scale in non-specific populations.[16] The MCID for the NPRS in patients with chronic pain, including severe OA, is 1.7.[17]

Active (AROM) and passive (PROM) knee ROM were assessed for flexion and extension in a seated position with feet flat on the floor using a long-armed goniometer. For both measurements, the stationary arm was aligned with the greater trochanter and the dynamic arm aligned with the lateral malleolus of the ankle with the axis oriented at the lateral knee joint in the center of rotation. Knee extension AROM was measured by asking the patient to actively "straighten" or "extend" the knee as far as possible and the value of AROM was recorded. Knee extension PROM immediately followed with the addition of overpressure by the physical therapist. A lower measure is preferred as zero degrees is the determined norm. Knee flexion AROM was measured by asking the patient to "flex" or "bend" the knee as far as possible while keeping the ischial tuberosity in contact with the sitting surface. Knee flexion PROM immediately followed with the addition of overpressure by the physical therapist. A higher measure is ideal for more degrees of motion allowing for increased functional mobility. For this assessment, a change of 6.3 degrees in knee extension and 9.8 degrees of knee flexion is the minimal detectable change (MDC) for patient following TKA.[18]

The 30s-CST is a test of strength, endurance, and functional balance. The maximum number of sit to stand repetitions performed without upper extremity assistance over a 30-second period represents the score for this test. A higher score shows increased

strength and endurance. A 44 cm chair (floor to seat surface) was placed against a wall to inhibit movement of the chair during the test. To begin, the participant sat in the chair with feet shoulder-width apart and flat on the floor. Participants crossed their arms in front of their chest. Participant were allowed one or two practice repetitions. Participants stood from the chair to reach full standing and returned to the seated position as many times as possible for the 30-second duration. Test-retest and intra-rater reliability are high for the 30-sCST, with coefficients of 0.97 and 0.93 respectively in patients waiting for TKA.[19] Reliability for the 30s-CST was also established in patient's post-TKA with a calculated inter-class coefficient of 0.92.[20] Construct validity was determined to be moderate to high in comparison to other valid functional tests in patients waiting for TKA.[19] The MDC for patients who are 6-weeks post-TKA is 1.56 stands.[21]

The TUG is a physical performance test that consists of the participant rising from a chair, ambulating three meters, turning around, returning to the chair, and sitting. The participants started the test procedure seated in a 44cm chair, with arms on the chair's armrests and back resting against the upright portion of the chair. The distance was marked clearly on the floor with adhesive tape. Participants were allowed one practice attempt prior to scoring. The tester recorded the duration of time from beginning of the test until the participant completed the ambulation task and returned to the start position. Use of an ambulatory aide was allowed for this test if needed for safety of the participant. A lower time designates a decreased falls risk. The TUG has high test-retest and inter-rater reliability in patients awaiting TKA, with ICCs of 0.75 and 0.87, respectively.[22] Construct validity is also high in correlation with various functional outcomes previously validated for patients awaiting TKA.[22] In patients post-TKA, the TUG was calculated to have reliability with an ICC of 0.98 and an MCD of 2.27 seconds.[23] The MDC, established in patients with varying degrees of OA, is 1.10-1.14 seconds.[24]

Data Analysis

Descriptive statistics were calculated for all baseline and discharge survey and functional assessments. Intention to treat (ITT) analysis was utilized for participants if they were discharged early or did not return for their final evaluation. A Spearman correlation analysis was conducted between patients' baseline scores on the STAI and all other surveys and functional measures from baseline and at discharge to assess the study's primary purpose. Friedman's test was used to evaluate changes in participants throughout their rehab progression. Cohen's d effect sizes were used to further evaluate the magnitude of differences between baseline and discharge. Effect sizes were interpreted as small (0.2), moderate (0.5) and large (0.8).[25] An alpha level of .05 was used to determine statistical significance. All analyses were conducted using SPSS 24.0 (IBM, Chicago, IL).

RESULTS

ITT analysis was utilized on two patients who did not complete discharge surveys, and functional testing. Results were calculated for nineteen participants, nine males and ten females, ages 36 to 76 years (62.7 ± 9.9 years). Baseline and discharge descriptive statistics of surveys and initial outcome measures for all participants are depicted in Tables 2 and 3. A main effect difference was shown ($\chi^2 = 348.7$, $p < .001$) with changes between pre- and post-testing in mLEFS ($p = .001$), pain ($p < .001$), knee flexion and extension PROM and AROM ($p < .001$ for all), TUG ($p < .001$) and 30s-CST ($p < .001$) in patients following TKA (Tables 2 and 3). There were large effect sizes for each variable that was different between pre- and post-testing, and the change between pre- and post-testing exceeded the MDC/MCID for all outcome measures (Table 3).

Table 2. This table depicts the mean and SD at baseline and discharge surveys.

	Baseline (n = 19)	Discharge (n = 19)	Effect Size (95% CI)
S-Anxiety	30.3 ± 11.0	28.3 ± 10.8	.18 (-.46, .82)
T-Anxiety	30.9 ± 10.3	28.8 ± 11.6	.19 (-.45, .82)
mLEFS	36.7 ± 18.2*	14.5 ± 11.6*	1.42 (.71, 2.14)
PCQ	9.6 ± 11.3	9.3 ± 12.0	.03 (-.61, .66)

Notes: * indicates a difference between baseline and discharge ($p < .05$). State anxiety (S-anxiety), Trait anxiety (T-anxiety), modified Lower Extremity Functional Scale (mLEFS), Pain Catastrophizing Questionnaire (PCQ)

Table 3. This table displays the mean and standard deviation for baseline and discharge outcome measures.

	Baseline (n = 19)	Discharge (n = 19)	Effect Size (95% CI)
NPRS	4.8 ± 1.9	1.7 ± 1.2*^	1.91 (1.14, 2.68)
Flexion AROM (°)	92.9 ± 13.7	116.3 ± 8.5*^	2.01 (1.23, 2.79)
Flexion PROM (°)	100.3 ± 6.1	121.8 ± 6.5*^	3.34 (2.36, 4.32)
Extension AROM (°)	7.84 ± 4.50	2.79 ± 2.55*	1.35 (.65, 2.06)
Extension PROM (°)	5.58 ± 4.15	1.47 ± 1.95*	1.24 (.55, 1.94)
TUG (sec)	16.7 ± 6.7	8.0 ± 1.9*^	1.73 (.98, 2.47)
30s-CST (reps)	6.3 ± 3.5	14.6 ± 4.2*^	2.10 (1.31, 2.89)

Notes: * indicates a difference between baseline and discharge ($p < 0.05$), ^ exceeds MDC/MCID. Numeric Pain Rating Scale (NPRS), active range of motion (AROM), passive range of motion (PROM, timed up and go (TUG), thirty-second chair stand test (30s-CST)

Tables 4 and 5 show the results of the correlations between anxiety and measures at baseline and discharge, respectively. Baseline S-anxiety had high correlations with baseline and discharge PCQ and 30s-CST (Table 4). These results partially align with the investigators' hypothesis. Baseline T-anxiety correlated with baseline and discharge PCQ and discharge NPRS scores (Table 4). Both discharge S- and T-anxiety scores correlated with discharge mLEFS, PCQ, and NPRS scores (Table 5). Data revealed no correlations between baseline S- and T-anxiety and discharge functional outcome measures including the TUG and 30s-CST (Table 4). The results partially align with the investigators' hypothesis.

Table 4. Correlations between baseline state and trait anxiety with baseline and discharge outcome measures. Data are shown as the correlation coefficient, rho, and the p-values are shown in parentheses, Rho (p-value).

		S-Anxiety	T-Anxiety
Baseline	mLEFS	-.098 (.691)	-.114 (.643)
	PCQ	.546 (.016)*	.676 (.001)*
	NPRS	.285 (.238)	.027 (.912)
	Flexion AROM	-.108 (.659)	-.163 (.506)
	Flexion PROM	.120 (.625)	-.127 (.604)
	Extension AROM	-.077 (.755)	.073 (.766)
	Extension PROM	-.123 (.616)	.250 (.303)
	TUG	.189 (.438)	.150 (.541)
	30-sec CST	-.531 (.019)*	-.086 (.727)
Discharge	mLEFS	.337 (.158)	.442 (.058)
	PCQ	.536 (.018)*	.462 (.046)*
	NPRS	.097 (.693)	.569 (.011)*
	Flexion AROM	.221 (.363)	.038 (.876)
	Flexion PROM	.171 (.484)	-.028 (.910)
	Extension AROM	-.049 (.843)	-.117 (.635)
	Extension PROM	.111 (.650)	-.018 (.943)
	TUG	.202 (.407)	-.180 (.460)
	30-sec CST	-.253 (.295)	.181 (.458)

Notes: * indicates $p < .05$.State anxiety (S-anxiety), Trait anxiety (T-anxiety), modified Lower Extremity Functional Scale (mLEFS), Pain Catastrophizing Questionnaire (PCQ), Numeric Pain Rating Scale (NPRS), active range of motion (AROM), passive range of motion (PROM, timed up and go (TUG), thirty-second chair stand test (30s-CST)

Table 5. Correlations between discharge state and trait anxiety with discharge outcome measures. Data are shown as the correlation coefficient, rho, and the p-values are shown in parentheses, Rho (p-value).

	S-Anxiety	T-Anxiety
mLEFS	.606 (.006)*	.675 (.002)*
PCQ	.577 (.010)*	.580 (.009)*
NPRS	.588 (.008)*	.707 (.001)*
Flexion AROM	-.183 (.454)	-.312 (.193)
Flexion PROM	-.278 (.248)	-.410 (.082)
Extension AROM	.274 (.257)	.141 (.565)
Extension PROM	.386 (.103)	.186 (.445)

TUG	.037 (.882)	-.084 (.734)
30-sec CST	-.140 (.567)	.168 (.493)

Notes: * indicates $p < .05$. State anxiety (S-anxiety), Trait anxiety (T-anxiety), modified Lower Extremity Functional Scale (mLEFS), Pain Catastrophizing Questionnaire (PCQ), Numeric Pain Rating Scale (NPRS), active range of motion (AROM), passive range of motion (PROM, timed up and go (TUG), thirty-second chair stand test (30s-CST)

DISCUSSION

Based on the data presented, investigators can determine the hypothesis was partially supported in that increased measure of baseline S-anxiety correlated with increased pain catastrophizing scores at baseline and discharge and decreased 30s-CST at baseline. Pain, ROM, and functional outcome measure performance improved from baseline to discharge for both groups, confirming that skilled PT interventions do improve perceived pain and function (Tables 2 and 3). S-anxiety, T-anxiety, and PCQ scores had no changes from baseline to discharge (Table 2). Patients who reported higher S-anxiety at baseline performed less chair stands in 30 seconds at baseline and reported higher pain catastrophizing tendencies at baseline and discharge, despite improved functional outcomes (Table 4). Patients who reported higher T-anxiety at baseline had increased pain catastrophizing and mLEFS scores indicating, regardless of functional outcomes, the patient perceived limitations in their functional abilities following TKA (Table 4). These findings indicate that patients with higher overall anxiety performed worse on functional outcomes shortly after TKA, but this relationship no longer existed at the time of discharge from PT. Additionally, approximately six weeks of intervention had no effect on anxiety levels or how patients perceived pain as indicated by the absence of change in patient reported outcomes from baseline to discharge.

Baseline S-anxiety had more correlations with baseline measures, as opposed to baseline T-anxiety which had more correlations with discharge measures. The significance of these findings highlights the nature of S-anxiety being heightened acutely whereas T-anxiety is persistent as the individual is predisposed to a chronic heightened state.[7,8] This aligns with previous research in that patients who have heightened situational anxiety have a lower activity tolerance.[1] These data echo this finding with higher baseline S-anxiety being correlated with fewer sit to stands performed in the 30s-CST as baseline assessment.

Both baseline S-and T-anxiety correlated with baseline pain catastrophizing tendencies and discharge mLEFS scores. These relationships highlight the importance of subjective and perceived ratings for pain and function. Prior research has shown T-anxiety to be a strong predictor of perceived functional outcomes in patients following TKA[2] which is consistent with the findings in this study where relationships between anxiety and pain catastrophizing tendencies are evident with correlations noted for both S- and T-anxiety at baseline and discharge. One possible explanation for this finding could be because anxiety manifests itself in physiological and behavioral symptoms[7], thus regardless of the subtype, increases in pain and catastrophizing tendencies would be expected especially in patients with history of OA.[9] S-anxiety is associated with higher overall pain ratings, and catastrophizing symptoms are a predictor of outcomes following TKA.[5,9,10] The results of the present study confirm these associations.

As expected, the functional outcomes used in this study, the mLEFS, pain, AROM, PROM, TUG, and 30s-CST showed significant improvements, exceeding the MDC/MCID, following six weeks of PT intervention. What is important to note is S- and T-anxiety and the PCQ scores had very little change between pre and posttest measures. Previous literature has concluded indications of higher pre-operative anxiety, depression, and PCQ scores indicated poor perceived functional outcomes post-operatively up to one year.[1-4] These data confirm that S-anxiety at baseline is related to pain catastrophizing and physical therapists can anticipate higher levels of pain with patients pursuing rehabilitation following TKA. Being able to identify pain catastrophizing tendencies can help healthcare providers avoid using language that may enhance these tendencies and further increase the patient's anxiety.

Limitations

There were several limitations to this study. Patients were all recruited from a physician-owned outpatient orthopedic surgical center, where pre-screening procedures established for TKA surgery excluded candidates with comorbidities including heart disease, diabetes, and obesity. Increased anxiety has been shown to be a symptom associated with obesity and type II diabetes, thus the subjects in the study who underwent surgery at this with this surgical group may not represent the population at large.[26,27] Previous history of diagnosed mental health disorders and individual medication regimens were also not considered or evaluated during patient selection. This may be why there were no significant correlations with anxiety and functional outcomes. An additional limitation is the use of an assistive device during the TUG Most patients utilized an assistive device at baseline and no device at discharge for the TUG. While assistive devices are permitted for use during the test, the use during one, but not the other could have potentially altered the validity of the comparisons between baseline and discharge measures.

CONCLUSION

It can be anticipated that patients with higher S- and T-anxiety will have increased pain, poorer self-reported functional outcomes and catastrophizing symptoms. Clinicians could implement screening tools to identify patients at risk for poorer outcomes secondary to psychological factors such as anxiety. Clinicians could then proactively incorporate relaxation techniques, stretching, and soft tissue manipulation as a standard means of care[28,29] to mitigate this issue. Cognitive-behavioral therapy (CBT) techniques have also been proven to enhance results of perceived and functional activity in chronic pain patients.[30,31] Recent studies have shown, CBT provided by physical therapists overall enhances clinical practice and can be an efficient tool in improving patient's overall wellness and functional activity.[30,31] While CBT requires specialized training, increased time to implement and challenges with reimbursement, further educational opportunities provided to clinicians to integrate techniques into standard practice could be crucial for overall functional improvements in patients with S- and T- anxiety undergoing TKA. Further research of introducing CBT practice models into the physical therapy profession would allow for opportunities to integrate the psychological and physical factors affecting patient's overall functional status. Additional research should explore targeted therapy approaches, their correlations with anxiety, and return to function. Supplementary research in this area could improve therapists' ability to develop individualized care plans, while also improving quality of life and return to function in patients undergoing TKA procedures.

ACKNOWLEDGEMENTS

This study originated through Campbell University's Doctor of Physical Therapy department. Data was collected from patients receiving treatment from the skilled therapists at Pinnacle Orthopeadics in Woodstock, GA, USA. The authors would like to thank Darlene Kelsesky for her contributions in collecting principal data and recruiting participants for this project.

AUTHOR CONTRIBUTIONS

All authors were involved in study design, data collection, synthesis, analysis, and interpretation. All authors contributed to the writing and editing of this manuscript and agree in the submission of the final version.

COMPETING INTERESTS

The authors declare they have no competing interests.

REFERENCES

1. Tonelli S, Rakel B, Cooper N, Angstrom W, Sluka K. Women with knee osteoarthritis have more pain and poorer function than men, but similar physical activity prior to total knee replacement. *Biol Sex Differ 2011*;2:12; doi:10.1186/2042-6410-2-12. [PMID: 22074728]
2. Cooper NA, Rakel B, Zimmerman B, Tonelli S, Herr K, Clark C, *et al.* Predictors of multidimensional functional outcomes after total knee arthroplasty. *J Orthop Res 2017*;35:2790-8. [PMID: 28471509]
3. Lingard E, Katz J, Wright E, Sledge C, Kinemax Outcomes Group. Predicting the outcome of total knee arthroplasty. *J Bone Joint Surg* 2004;86(10):2179-86. [PMID: 15466726]
4. Vissers M, Mussmann J, Verhaar J, Busschbach J, Bierma-Zeinstra S, Reijman M. Psychological factors affecting the outcome of total hip and knee arthroplasty: a systematic review. *Semin Arthritis Rheum* 2012;41:576-88. [PMID: 22035624]
5. Bonnin M, Basiglini L., Archibald,P. What are the factors of residual pain after uncomplicated TKA? *Knee Surg Sports Traumatol Arthrose* 2011;19:1411-7. [PMID: 21598009]
6. McDonald S, Page M, Beringer K, Wasiak J, Sprowson A. Preoperative education for hip or knee replacement. *Cochrane Database of Systematic Reviews* 2014;5:1-88. DOI:10.1002/14651858.CD003526.pub3. [PMID: 24820247]
7. Lox C, Martin-Ginis K, Petruzzello S. Anxiety and Exercise. In: The Psychology of Exercise: Integrating theory and practice. 4th ed. Scottsdale: Holcomb Hathaway Publishers Inc; 2014. p. 258-82.
8. Spielberger C, Gorsuch R., Lushene R, Vagg P, Jacobs G. Manual for the state-trait anxiety inventory (Form Y) ("Self-evaluation questionnaire") 1983. Palo Alto, CA: Consulting Psychologists Press, Inc.
9. Marks R. Anxiety and its impact on osteoarthritis pain: an update. *J Rheum Dis Treat* 2015;1(3):1-6.
10. Feeny S. The relationship between pain and negative affect in older adults: anxiety as a predictor of pain. *Anxiety Disorders* 2004;18:733-44. [PMID: 15474849]
11. Sullivan M., Bishop S, Pivik J. The pain catastrophizing scale: development and validation. *Psychological Assessment* 1995;7(4):524-32.
12. Dobson F, Hinman R, Roos E, Abbott J, Stratford P, Davis A, et al. OARSI recommended performance-based tests to assess physical function in people diagnosed with hip or knee osteoarthritis. *Osteoarthritis and Cartilage* 2013;21:1042-52. PMID: 23680877
13. Julian, L. Measures of anxiety: State-Trait Anxiety Inventory (STAI), Beck Anxiety Inventory (BAI), and Hospital Anxiety and Depression Scale-Anxiety (HADS-A). *Arthritis Care Res* 2011;63:1-11. [PMID: 22588767]

14. Suzuki H, Aono S, Inoue S, Imajo Y, Nishida N, Funaba M, et al. Clinically significant changes in pain along the pain intensity numerical rating scale in patient with chronic low back pain. *PLoS ONE 2020;*15. [PMID: 32126108]
15. Kennedy D, Stratford P, Riddle D, Hanna S, Gollish J. Assessing recovery and establishing prognosis following total knee arthroplasty. *Phys Ther* 2008;88:22-32. [PMID: 17986495]
16. Herr K, Spratt K, Mobily P, Richardson G. Pain intensity assessment in older adults: use of experimental pain to compare psychometric properties and usability of selected pain scales with younger adults. *Clin J Pain* 2004;20(4):207-19. [PMID: 15218405]
17. Farrar J, Young J, et al. Clinical importance of change in chronic pain intensity measures on an 11-point numerical pain rating scale. *Pain* 2001;33(3):232-42. [PMID: 11690728]
18. Stratford P, Kennedy D, Robards S. Modelling knee range of motion post arthroplasty: clinical application. *Physiother Can* 2010;62(4):378-87. [PMID: 21886379]
19. Gill S, de Morton N, McBurney H. An investigation of the validity of six measurements of physical function in people awaiting joint replacement surgery of the hip or knee. *Clin Rehab* 2012;26(10):945-51. [PMID: 22324057]
20. Unver B, Kalkan S, Yuksel E, Kahraman T, Karatosun V. Reliability of the 50-foot walk test and 30 sec – chair stand test in total knee arthroplasty. *Acta Ortop Bras* 2015;23(4):184-87. [PMID: 26327798]
21. Van Bussel, JL. Reliability and validity of two performance-based outcome measures in rehabilitation following total knee arthroplasty [dissertation]. Electronic Thesis and Dissertation Repository; 2019.
22. Kennedy D, Startford P, Wessel J, Gollish J, Penney D. Assessing stability and change of four performance measures: a longitudinal study evaluating outcome following total hip and knee arthroplasty. *BMC Muskuloskelet Disord* 2005;6(3):Doi:10.1186/1471-2474-6-3. [PMID: 15679884]
23. Yuksel E, Kalkan S, Cekmece S, Unver B, Karatosun V. Assessing minimal detectable changes and test-retest reliability of the timed up and go test and the 2- minute walk test in patients with total knee arthroplasty. *J. Arthroplasty* 2017;32(2):426-30. [PMID: 27639305]
24. Alghadir A, Answer S, Brismee J. The reliability and minimal detectable change of Timed Up and Go test in individual with grade 1-3 knee osteoarthritis. *BMC Muskuloskelet Disord* 2015;16;174. [PMID: 26223312]
25. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale, NJ: Erlbaum; 1988.
26. Gariepy G, Nitka D, Schmitz N. The association between obesity and anxiety disorders in the population: a systematic review and meta-analysis. *Int J Obes* 2010;34:407–19. [PMID: 19997072]
27. Weaver L, Madhu S. Type 2 diabetes and anxiety symptoms among women in New Delhi, India. *Am J Public Health* 2015;105(11):2335-40. [PMID: 26378851]
28. Buttagat V, Eungpinichpong W, Chatchawan U, Arayawichanon P. Therapeutic effects of traditional Thai massage on pain, muscle tension, and anxiety in patients with scapulocostal syndrome: A randomized single-blinded pilot study. *J Bodyw Mov Ther* 2012;16:57-63. [PMID: 22196428]
29. Sharififar F, Sharififar F, Khademi M. The effect of stretching exercises education on mental health and learning strategies. *Report of Health Care* 2017;3(4):25-30.
30. Nielsen M, Keefe F, Bennell K, Gwendolen A. Physical therapists-delivered cognitive-behavioral therapy: A qualitative study of physical therapists' perceptions and experiences. *Phys Ther.*2014;94(2):197-209. [PMID: 24029300]
31. Beissner K, Henderson C, Papaleontiou M, Olkhovskaya Y, Wigglesworth J, Reid M. Physical therapists' use of cognitive-behavioral therapy for older adults with chronic pain: A nationwide survey. *Phys Ther.* 2009;85(5):456-69. [PMID: 19270046]