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Original research

Patient Resilience Has Moderate Correlation With Functional Outcomes, but Not Satisfaction, After Primary Unilateral Total Knee Arthroplasty

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ABSTRACT

Background: As many as 20% of patients who undergo total knee arthroplasty (TKA) are dissatisfied. Psychological factors have been shown to play a role in outcomes after TKA. The purpose of this study was to investigate the impact of patient resilience on functional outcomes and satisfaction after primary unilateral TKA.

Methods: Eighty-six patients who underwent primary unilateral TKA by a single surgeon were studied. Primary outcomes were the Brief Resilience Scale (BRS), mental health component of the Veterans Rand 12-Item Health Survey (VR-12 MCS), Knee Injury and Osteoarthritis Outcome Score for Joint Replacement, and New Knee Society Score. Correlations between BRS and dependent variables were found by using Spearmen's Rho Correlation testing. Unadjusted and adjusted regressions were run using the delta values as the dependent outcome and the BRS score as the main independent value, with data presented as an estimate of 95% confidence interval *P* value.

Results: Resilience significantly correlated with male sex ($P = .031$), preoperative VR-12 MCS scores ($P = .013$), and postoperative VR-12 MCS scores ($P < .001$). BRS had moderate correlation with postoperative Knee Society Scores (KSS) Functional Activity Scores, as this approached, but did not achieve statistical significance ($P = .062$). There was no correlation between BRS and postoperative KSS Patient Expectations score, KSS Patient Satisfaction score, or total postoperative opioid usage.

Conclusions: Primary TKA patients with greater resilience are more likely to be male and have better mental health characteristics than those with lower resilience. Patients with greater resilience also tended to have improved knee function after TKA, although this was not statistically significant. Resiliency did not correlate with postoperative opioid consumption or patient satisfaction after TKA.

Introduction

Total knee arthroplasty (TKA) has been shown to provide remarkable pain relief and improvement in function and quality of life in patients suffering with advanced osteoarthritis of the knee [1]. Approximately 90% of TKA implants remain intact at 20 years, exemplifying the sustained durability of this procedure [1,2]. Despite clear clinical benefits, as many as 20% of patients report dissatisfaction after TKA [3-5]. The exact cause of dissatisfaction after TKA is elusive, but likely multifactorial, including suboptimal knee function, persistent pain, and an unnatural feeling of the knee with implants in place [3,6].

Variables such as socioeconomic status and mental health have been shown to have a role in patients' perceptions of their outcomes. Patients with higher preoperative mental health scores have been shown to experience greater improvement in knee pain and perception of function than patients with lower mental health scores [7]. Those with worse preoperative mental health often display more negative coping behaviors and report poorer control of pain after TKA [8]. Furthermore, patients undergoing TKA, who consume opioids preoperatively, are more likely to consume opioids, experience greater pain, and report dissatisfaction at 1 year postoperatively [9].

With the increasing reliance on value-based metrics, patient-reported outcome measures (PROMS) are commonly used to assess quality and outcomes after TKA. With respect to joint arthroplasty, PROMS tend to focus on limb function, general activities, and physical health, while undervaluing the role that

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mental health and socioeconomics may play in outcomes [10]. This may be neglectful because as many as 50% of patients who undergo total joint arthroplasty (TJA) present with at least one psychological comorbidity that may influence their treatment results [11]. Patients with preoperative psychological comorbidities have been reported to experience more pain after TKA at up to 2 and 5 years after surgery [12].

There has been a growing interest in identifying psychological traits that may influence functional outcomes or patient satisfaction and their perceptions of the outcomes. One such trait is resilience, defined as the ability to recover from stressful events [13]. In the realm of TJA, it is therefore conceivable that patient resilience may impact functional outcomes, sense of satisfaction, and pain after surgery. Several studies have investigated the relationship between resilience and outcomes after orthopedic procedures. One study showed that higher resilience correlated with superior outcomes after total shoulder arthroplasty [14]. Another found that preoperative resilience was a significant predictor of postoperative mental and physical health and that higher concurrent resilience predicted better knee functionality, physical health, mental health, and quality of life after TKA [15].

We posit that patient resilience correlates with narcotic usage and patient-reported functional outcomes after TKA. The purpose of this study was to investigate the relationship between patient resilience, mental health and functional outcomes, and satisfaction up to 2 years after primary unilateral TKA.

Material and methods

Upon obtaining approval from the institutional review board, a consecutive series of patients who underwent TKA by a single surgeon at our institution were contacted to complete Brief Resilience Scale (BRS) questionnaires. Patients were included in the study if they underwent primary unilateral TKA for the diagnosis of osteoarthritis, had a minimum of 1 year, and up to 2 years, follow-up, and had prospectively collected preoperative and postoperative functional outcomes measures as described in the following section. Those who underwent simultaneous bilateral TKA, staged bilateral TKA 6 months apart, or revision TKA were excluded. An a priori power analysis was performed using the correlation values between 12-month Knee Injury and Osteoarthritis Outcome Score for Joint Replacement (KOOS, Jr.) and concurrent BRS scores as reported by Magaldi et al. [15]. To produce a medium effect size with an alpha of 0.05 and a power of 80%, a total of 81 patients were determined to be needed to detect a correlation between postoperative KOOS, Jr. and BRS.

Using a prospectively maintained institutional database, preoperative and minimum 1-year postoperative PROMS, including new Knee Society Scores (KSS), KOOS, Jr., and the validated mental health component of the Veterans Rand 12-Item Health Survey (VR-12 MCS), were retrospectively reviewed for each patient. The KOOS, Jr. and new KSS are validated, responsive, and reliable measures of knee health and function [16,17]. Patients were contacted to obtain responses to the BRS. The BRS is a 6-question survey that is shown to be an adequate and reliable tool to assess reliability [13]. Questions are graded on a scale of 1 to 5 and added for a total score of 30 points. To obtain a BRS score, the total score is divided by 5. Those with scores from 1.00 to 2.99 are deemed to have low resilience, 3.00 to 4.30 to have normal resilience, and scores of 4.31 to 5.00 to have high resilience [13].

Total opioid usage was also calculated, recorded in morphine milligram equivalents, from a timeframe extending from 1 month preoperatively to 6 months postoperatively, by using the Pennsylvania Online Prescription Drug Monitoring Program and the New Jersey Prescription Monitoring Program. The Pennsylvania Online Prescription Drug Monitoring Program and New Jersey Prescription Monitoring Program have a reported accuracy of up to 97% and document all controlled substance prescriptions in a consortium of states.

A simple bivariate analysis was performed, analyzing the relationship of this split with the other variables. Continuous data are presented as either mean (standard deviation) for parametric data or median [first quartile; third quartile] for nonparametric data. All categorical data are presented as cell count (percent of total count). Analysis of variance or Kruskal-Wallis test was performed depending on its normality to determine the P value for all continuous variables. Chi-square testing was used for categorical data. After this analysis, a set of Spearman's Rho correlations were ran to asses relationships among variables. These tests were performed using BRS score as the main variable of interest compared with all variables. Finally, a set of unadjusted and adjusted regressions were ran, using change in outcome scores over time as the dependent variable. All decisions of significance were made at P value $< .05$. All statistical analyses were carried out using R Studio (Version 3.6.3).

Results

Eighty-six consecutive patients (49 men, 37 women), with complete preoperative and postoperative function scores, that underwent unilateral primary TKA by a single surgeon (JHL) at our institution were included in the study. The average BMI for our cohort was 29.8 (±4.47), and the median age was 66.0 [58.5; 71.0]. The demographics of the patients are summarized in Table 1.

Our cohort had a median BRS score of 4.17 [3.71; 4.46] at a minimum of 1 year after surgery. The median value for preoperative VR-12 MCS scores was 58.5 [53.0; 62.8], and this value slightly increased to 62.1 [57.4; 63.7] at the most recent follow-up. Preoperative KOOS, Jr. scores had a median value of 50.0 [42.3; 58.8], and this value increased to 79.9 [70.7; 92.0] at the most recent follow-up. All postoperative functional parameters significantly improved from their baseline values, including knee function ($P < .001$), reduced symptoms ($P < .001$), and greater satisfaction ($P < .001$) based on comparison of preoperative and postoperative KSS. However, patient expectations decreased significantly after surgery ($P < .001$) (Table 2).

There was a statistically significant correlation between male gender and having greater resilience (BRS), $r = 0.233$, $P = .031$. However, there was no statistically significant correlation between BRS and other demographic variables (age, race, BMI). No correlation was found between BRS and preoperative KOOS, Jr., $r = 0.082$, $P = .456$, or postoperative KOOS, Jr. scores. There was no correlation between resilience and KSS Patient Expectation, Patient Satisfaction, and Symptoms scores. However, patients who were more resilient tended to have higher postoperative KSS Functional Activities, $r = 0.215$, and this approached statistical significance, $P = .062$. BRS had a moderate, but statistically significant, correlation with preoperative VR-12 MCS scores, $r = 0.270$, $P = .013$. In addition, the correlation with VR-12 MCS reported at a minimum of 1 year after surgery was found to be stronger, $r = 0.428$, $P < .001$.

No correlation was reported between BRS and preoperative opioid usage, $r = -0.121$, $P = .290$, or postoperative opioid usage, $r =$

Table 1
Demographics.

Age	66.0 [58.5; 71.0]
Gender	49 Male (57%), 37 Female (43%)
BMI	29.8 (±4.47)
Race	74 Caucasian (86%), 12 Other (14%)

Table 2
Summary of preoperative and minimum 1-year postoperative PROMS.

Outcomes measure	Preoperative	Minimum 1-year postoperatively	Change from preoperative to postoperative, *P* value
BRS		4.17 [3.71; 4.46]	
VR-12 MCS	58.5 [53.0; 62.6]	62.1 [57.4; 63.7]	.008
KOOS, Jr.	50.0 [42.3; 58.8]	79.9 [70.7; 92.0]	<.001
KSS Functional Activities	43.7 (±15.2)	81.0 [72.5; 90.0]	<.001
KSS Patient Satisfaction	14.0 [10.0; 18.0]	36.0 [30.0; 40.0]	<.001
KSS Patient Expectations	15.0 [14.0; 15.0]	11.0 [9.0; 13.0]	<.001
KSS Symptom Scores	8.24 [4.11; 11.6]	22.0 [20.0; 24.0]	<.001

All values are reported in median and interquartile ranges with the exception of KSS Functional Activities.

-0.157, $P = .166$. Furthermore, no relationship was found between BRS and reoperations, r = -0.002, $P = 0.989$, or postoperative complications, $P = .061$, r = 0.575. No correlation was found between BRS scores and improvement in VR-12 MCS, KOOS, Jr., or any KSS parameter between the preoperative and minimum 1-year postoperative time points (Table 3).

Since male patients in our cohort were found to have greater resilience than female patients, a secondary analysis was performed to determine whether male gender correlated with a series of dependent variables, including KOOS, Jr. and components of KSS. We found no statistically significant correlations between gender and postoperative KOOS, Jr., KSS Functional Activity, KSS Patient Expectation, and KSS Symptom Scores. However, male patients tended to have higher preoperative KOOS, Jr., KSS Functional Activity, KSS Patient Satisfaction, and KSS Symptom scores, and all these values approached statistical significance ($P = .087$, $P = .075$, $P = .087$, and $P = .064$), respectively (Table 4). Male patients were not likely to experience more improvement from their preoperative values than female patients, and gender did not correlate with either preoperative mental health (r = 0.067, $P = .542$) or postoperative mental health (r = 0.049, $P = .661$).

Table 3
A summary of the correlation values between BRS and the dependent variables of interest.

Variable	Correlation value (r)	*P* value
Age	0.083	.446
Sex	0.233	.031
Race	0.029	.794
BMI	−0.054	.620
Preop VR-12 MCS	0.270	.013
Preop KOOS, Jr.	0.082	.456
Preop KSS Functional Activities	0.149	.180
Preop KSS Patient Expectations	0.101	.363
Preop KSS Patient Satisfaction	−0.007	.948
Preop KSS Symptoms	0.100	.385
Postop VR-12 MCS	0.428	<.001
Postop KOOS, Jr.	0.091	.411
Postop KSS Functional Activities	0.215	.062
Postop KSS Patient Expectations	0.176	.125
Postop KSS Patient Satisfaction	0.112	.328
Postop KSS Symptoms	0.059	.609
Reoperations	−0.002	.989
Complications	0.061	.575
6-Month preop opioid usage (MME)	−0.121	.290
6-Month postop opioid usage (MME)	−0.157	.166
Change in VR-12 MCS	0.080	.478
Change in KOOS, Jr.	0.033	.767
Change in KSS Functional Activity	0.075	.524
Change in KSS Patient Expectation	0.105	.368
Change in KSS Patient Satisfaction	0.113	.334
Change in KSS Symptom	0.036	.756

Those with correlation values between -0.200 and 0.200 had no correlation, between 0.200 and 0.400 had moderate correlation, and values >0.400 had strong correlation.

Adjusted and unadjusted regression analyses with BRS as the independent variable and preoperative and postoperative VR-12 MCS, KOOS, Jr., KSS Functional Activity, KSS Patient Expectation, and KSS Patient Satisfaction were run to show whether an increase in BRS led patients to experience greater improvement between their preoperative and postoperative outcome metrics. While the adjusted regressions showed stronger correlations between BRS and changes in VR-12 MCS, KOOS, Jr., parameters of the KSS Survey with the exception of expectations, and postoperative opioid usage (morphine milligram equivalents), none of these correlations reached statistical significance. These results suggest that having greater resilience does not lead patients to experience greater recovery from baseline health (Table 5).

Discussion

Approximately 1 in 5 patients reports dissatisfaction after TKA [18]. Understanding the multifactorial etiology of patient dissatisfaction is confounded by the finding that patients may be dissatisfied despite satisfactory clinical outcomes [5,19-21]. With the advent of value-based care bundle payments offering provisions for the collection of PROMS and satisfaction remaining the most desired outcome metric, further investigation is necessary to identify and better understand potentially modifiable sources of dissatisfaction and outcomes for patients undergoing TKA [22].

While PROMS are an important tool in determining outcomes, those that also assess mental health variables are often underutilized, but which may nonetheless influence perception of outcomes and patient satisfaction after TKA. Patients with worse mental health have been shown to be more likely to be dissatisfied with their TKAs [23]. Andrawis et al. [24] demonstrated that patients with the skills, knowledge, and motivation to engage in adaptive health behaviors reported better pain relief, decrease in symptoms, improved mental health, and greater satisfaction after TJA.

Patient resilience has been shown to influence outcomes after surgery in several studies [14,15,25]; our results are less definitive. We found a statistically significant correlation between resilience and both preoperative and postoperative mental health, which is consistent with others [15,25]. Magaldi et al. [15] found that preoperative and concurrent resilience measures (BRS) significantly correlated with physical health, mental health, and quality of life at 3 and 12 months postoperatively. Unlike our results, concurrent BRS in their study was found to significantly correlate with KOOS, Jr., at 3 months ($P < .001$) and 12 months postoperatively ($P = .006$) although preoperative BRS did not. The reason for this discordance between preoperative resilience and concurrent resilience on correlation with functional outcomes is unclear, other than surmising that resilience may be affected and altered by life circumstances and events. In contrast, in our study, BRS, which was measured concurrently and not preoperatively, did not correlate with KOOS, Jr., although it moderately correlated with postoperative KSS Functional Activity Scores, approaching statistical significance. However,

Table 4
A summary of the correlations between gender and dependent variables.

Variable	Correlation value (r)	*P* value
KOOS, Jr.		
Preop	0.185	.087
Postop	0.098	.374
Delta	−0.069	.532
KSS Functional Activity		
Preop	0.196	.075
Postop	0.145	.210
Delta	−0.081	.492
KSS Patient Expectation		
Preop	0.072	.519
Postop	0.145	.210
Delta	0.093	.425
KSS Patient Satisfaction		
Preop	0.189	.087
Postop	0.128	.265
Delta	−0.012	.915
KSS Symptom		
Preop	0.204	.064
Postop	0.188	.100
Delta	−0.115	.328

The sex of reference used is male.

given the correlation between mental health and functional outcomes of TKA in our study and others [7,8,26], we are challenged to explain why our study failed to show statistically significant correlations between resilience and functional outcomes.

Lynskey et al. [27] investigated the relationship between Connor Davidson 10-item resilience scale (CD-RISC 10) and satisfaction in patients undergoing TJA. In their study, resilience was found to correlate with satisfaction ($P < .001$), with those who were more resilient demonstrating greater satisfaction than those with lower resilience. Unlike Lynskey et al. [27], we found no correlation between BRS and patient satisfaction according to the KSS scores. While Lynskey et al. [27] included both patients undergoing TKA and THA and used different PROMS to evaluate resilience and satisfaction, we do not believe the differences in methodology accounted for the contrasting findings. After further subgroup analysis, the correlation value between CD-RISC 10 and VAS-Satisfaction was found to be 0.31 for the TKA subgroup and 0.38 for the THA subgroup, while CD-RISC 10 was also found to have a correlation value of 0.44 and 0.41 with Net Promoter Scale for the TKA and THA subgroups, respectively. While both analyses showed that the correlation values for the THA and TKA subgroups were significantly different, ($P < .01$) in both cases, the correlation values for patients undergoing TKA were greater than the ones we reported between BRS and postoperative KSS patient satisfaction ($r = 0.112$, $P = .328$).

On the other hand, our findings seem to agree with those from another study [28], which measured the relationship between postoperative outcomes and preoperative BRS in arthroscopy patients. Both studies found that BRS does not correlate with postoperative satisfaction and functional outcomes.

To our knowledge, ours is the first study to assess the relationship between the BRS and new KSS. The new KSS has validated subsections to quantify expectations and satisfaction as well as functional outcomes [17]. While we hypothesized that patients with greater resilience would display greater satisfaction and meeting of expectations after TKA, our study did not find this to be the case. In fact, we found no statistically significant correlation between BRS and any component of the KSS, including satisfaction and expectations.

Our findings showed that resilience correlated significantly with male gender, with men scoring higher on BRS than women. This seems to be in agreement with those of other studies, which suggest that women score lower on measures of resilience and handle stress less adeptly [13,29-31]. Despite gender correlating with mental health and resilience, we did not find gender to correlate with postoperative functional outcomes.

We also found no correlation between resiliency and preoperative or postoperative opioid consumption. These findings were inconsistent with our hypothesis because literature has shown that patients with mental health challenges are more likely to have negative coping habits and suffer from substance abuse [32]. Nevertheless, these findings are in agreement with those of Wojahn et al., which showed no correlation between resilience and opioid usage after arthroscopy [33]. We found no other studies looking at opioid consumption relative to resilience after TJA.

One potential weakness of our study was despite being adequately powered to study the primary outcomes, we were underrepresented in the “low-resilience” cohort. Based on the criteria established by Smith et al. [13], 2 of our patients had low resilience, 50 had moderate resilience, and 34 had high resilience. While no studies have assessed BRS at the population level, there is a possibility that our study cohort may be more resilient than the general population, and this lack of heterogeneity may have skewed our results. It is not clear whether our data and conclusions regarding dissatisfaction, opioid consumption, and functional outcomes would have varied had we had a larger cohort of low-resilience patients, but further study may elucidate this issue. Second, we did not have preoperative BRS scores, which may have different values than postoperative/concurrent scores and thus inform

Table 5
Regression analysis.

Outcomes measure	Unadjusted	Adjusted
Dependent variable		
Delta MCS score		
BRS score	1.34 (−1.28 to 3.97) ($P = .317$)	1.59 (−1.03 to 4.22) ($P = .237$)
Delta KOOS		
BRS score	2.12 (−5.78 to 10.02) ($P = .601$)	2.45 (−5.75 to 10.66) ($P = .559$)
Delta KSS Functional Activity score		
BRS score	3.42 (−3.56 to 10.39) ($P = .341$)	4.35 (−2.70 to 11.39) ($P = .231$)
Delta KSS Expectation score		
BRS score	0.98 (−0.41 to 2.37) ($P = .172$)	0.80 (−0.68 to 2.28) ($P = .291$)
Delta KSS Satisfaction score		
BRS score	1.68 (−2.08 to 5.44) ($P = .384$)	1.97 (−1.65 to 5.59) ($P = .290$)
Delta KSS Symptom score		
BRS score	0.89 (−1.69 to 3.48) ($P = .500$)	1.32 (−1.29 to 3.93) ($P = .326$)
Postop opioid		
BRS score	255.3 (−543.17 to 1053.72) ($P = .533$)	337.77 (−495.50 to 1171.04) ($P = .429$)

All adjusted models included age, sex, and BMI.

different relationships/correlations with the outcomes we studied. While resilience has been shown to be a stable trait [15], our study would have been stronger if BRS scores were collected preoperatively and at different time-points postoperatively to control for confounding effects of surgery and the postoperative rehabilitation process and to assess whether resilience was a stable trait in our patient population. Finally, our study used a multistate database to assess narcotic prescription amounts as a surrogate measure of opioid consumption. However, while this method assumes that the prescription amounts correlate with consumption, in reality, patients may not have consumed the entirety of the prescribed medications. A prospective daily medication log would have been more precise and eliminated assumptions regarding medication use.

Conclusions

Patients undergoing primary unilateral TKA with greater resilience are more likely to be male and have better mental health preoperatively at a minimum of 1 year after surgery. Patients with greater resiliency also exhibited greater knee function postoperatively, and this approached statistical significance. However, resiliency did not correlate with preoperative and postoperative opioid consumption, satisfaction, or expectations being met. Preoperative assessment of resilience can be considered in the shared decision-making process with patients. Further research is needed to determine if resilience is a modifiable trait and, if so, whether preoperative interventions to enhance resilience could improve outcomes.

Conflicts of interest

One author (JHL) has the following conflicts of interest: Royalties (Zimmer Biomet; Smith and Nephew); Paid consultant: (Zimmer Biomet; Smith and Nephew); Research support from a company as a Principal Investigator (Zimmer Biomet; Smith and Nephew); Committee Member (American Association of Hip and Knee Surgeons; Knee Society); Stock Options (Force Therapeutics); Royalties from Publisher (Springer International Publishing). All other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this aticle.

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