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Adversarial Growth after Anterior Cruciate Ligament Reconstruction

Britton W. Brewer,
Springfield College, Springfield, Massachusetts

Allen E. Cornelius,
University of the Rockies, Colorado Springs, Colorado

Judy L. Van Raalte, and
Springfield College, Springfield, Massachusetts

Howard Tennen
University of Connecticut Health Center, Farmington, Connecticut

Abstract

Although psychological research on sport injury has long focused on negative responses to injury, investigators have begun to explore positive consequences as well. This study examined adversarial growth longitudinally after anterior cruciate ligament (ACL) surgery and rehabilitation. Participants (N = 108) completed questionnaires measuring: (a) aspects of adversarial growth before ACL surgery and at 6, 12, and 24 months after surgery; and (b) daily pain and negative mood for 42 days postoperatively. Although most participants reported little or no adversarial growth due to their injury and rehabilitation, significant increases over preoperative values were found at 6 months postsurgery for three aspects of adversarial growth. Daily pain and negative mood were positively associated with aspects of adversarial growth at 6- and 12-months postsurgery. It appears that modest, but detectable increases in aspects of perceived adversarial growth can occur after ACL reconstruction and be related to indices of adversity experienced during rehabilitation.

Keywords

knee; positive; psychology; surgery

From the initial published study of the psychological consequences of sport injury (Little, 1966) to the current decade, research on how athletes respond psychologically to injury has had a decidedly negative tone. A wide variety of adverse cognitive (e.g., intrusive thoughts, decreased self-esteem), emotional (e.g., anger, anxiety, sadness, fear), and behavioral (e.g., suicide, disordered eating, alcohol consumption) reactions to sport injury have been documented (Leddy, Lambert, & Ogles, 1994; Martens, Dams-O'Connor, & Beck, 2006; Shuer & Dietrich, 1997; Smith & Milliner, 1994; Sundgot-Borgen, 1994; Wiese-Bjornstal, Smith, Shaffer, & Morrey, 1998). Such negativity is understandable in light of the goal disruption, pain, physical limitations, social isolation, threats to identity, and other aversive experiences that can accompany sport injury (Petitpas & Danish, 1995).

Despite the preponderance of seemingly negative psychological consequences, the responses of athletes to injury are not uniformly negative. Indeed, the vast majority of a sample of elite skiers with injuries reported experiencing one or more benefits as a result of incurring their injuries (Udry, Gould, Bridges, & Beck, 1997). Although some of the positive consequences of injury pertained to physical-technical development (e.g., skiing with better technique), most of the skiers identified psychological benefits in the areas of personal growth (e.g., developing non-sport interests, becoming a more empathic person) and psychologically-based performance enhancement (e.g., improving mental toughness, increasing motivation). Results of other qualitative studies have substantiated and elaborated on the themes of positivity described by Udry et al. (1997). Specifically, the studies (e.g., Galli & Reel, 2012b; Galli & Vealey, 2008; Podlog & Eklund, 2006; Rodenkirk, 1999; San José, 2003; Tracey, 2003; Wadey, Clark, Podlog, & McCullough, 2013; Wadey, Evans, Evans, & Mitchell, 2011) have provided additional examples of the themes that Udry et al. identified, documented perceived benefits of injury in samples of athletes in sports other than skiing, and, in some cases, identified themes not evident in the responses of the participants in the Udry et al. study.

The notion of people incurring positive consequences as a result of experiencing adversity is not new, as evidenced by the oft-paraphrased quote of Nietzsche (1889/1990) from more than a century ago: “From life’s school of war: what does not kill me makes me stronger.” Reports of growth have been documented for a wide variety of adverse events, including those that involve threats to health and physical functioning (for a review, see Linley & Joseph, 2004). Various terms have been used to describe growth occurring after experiencing such circumstances, including adversarial growth (Linley & Joseph, 2004), benefit finding (Tennen & Affleck, 2002), perceived benefits (McMillan & Fisher, 1998), posttraumatic growth (Tedeschi & Calhoun, 1996), and stress-related growth (Park, Cohen, & Murch, 1996). As noted by Joseph and Linley (2006), the “terms have been used interchangeably, and there is not a single agreed collective term for this field of study” (p. 1042). Because we sought to examine positive changes after sport injury in a general sense, without considering whether the injury and its sequelae were traumatic versus merely stressful, we used the term adversarial growth (Linley & Joseph, 2004) in the current study.

Several theoretical perspectives have been developed to explain why and how people might benefit from adversity. Among the most widely studied perspectives are a functional-descriptive model (Calhoun, Cann, & Tedeschi, 2010; Calhoun & Tedeschi, 1998; Tedeschi & Calhoun, 1995, 2004), an organismic valuing theory (Joseph & Linley, 2005), and an affective-cognitive processing model (Joseph, Murphy, & Regel, 2012). All three approaches have been used to guide research on reports of growth experienced after sport injury and other adverse events encountered by athletes (e.g., Galli & Reel, 2012a; Howells & Fletcher, 2015; Wadey, Podlog, Galli, & Mellalieu, 2016). Although there are differences among the three perspectives, they can be viewed as more complementary than competing. Each of the models focuses on how growth is a product of the cognitive processing that occurs in response to the disruptive impact that stressful and traumatic events can have on people’s views of themselves and the world (Joseph & Linley, 2006). Cognitive processes of importance in experiencing growth after adverse events are appraisal (i.e., interpreting the personal relevance of the event and one’s ability to deal with it), assimilation (i.e.,

incorporating the event into existing views of oneself and the world), and accommodation (i.e., developing new views of oneself and the world that incorporate the event). Cognitive processes, particularly appraisal, are central in the integrated model of psychological response to sport injury (Wiese-Bjornstal et al., 1998).

Consistent with the tenets of the functional-descriptive model, organismic valuing theory, and affective-cognitive processing model, Galli and Vealey (2008) argued that adverse events such as injury can have an agitating effect on athletes, producing unpleasant emotions, mental struggles, and deployment of coping strategies that, in combination, can facilitate positive outcomes (e.g., learning valuable lessons, gaining perspective, appreciating support from others, becoming stronger). Thus, athletes who sustain injuries but experience no agitation in the aftermath of the injuries would be expected to report less growth than those who experience agitation. In support of this notion, it has been shown outside of the sport domain that perceptions of the severity or adverse impact of stressors are positively associated with adversarial growth (Armeli, Gunthert, & Cohen, 2001; Park et al., 1996; Tedeschi & Calhoun, 1996).

Although the literature on the positive psychological consequences of sport injury has been useful in identifying the domains in which benefits are experienced after injury, the reliance on retrospective and cross-sectional research designs has limited the extent to which the temporal dynamics of postinjury adversarial growth are understood. It is important to use methods that reflect that growth is fundamentally a process, not an event. Consequently, researchers have called for the implementation of longitudinal studies to examine the course of adversarial growth after sport injury (e.g., Galli & Reel, 2012b; Wadey et al., 2011). Outside the sport injury literature, although it has been assumed that perceived benefits emerge “relatively late in the process of adapting to a major loss or threatening event… benefits appear to be found within weeks of the event and retained for many years” (Tennen & Affleck, 2002, pp. 590–591). Specific to sport injury, however the retrospective qualitative findings of Wadey et al. (2011) suggest that athletes may experience different kinds of benefits during different phases of the injury recovery process. For example, athletes might experience a strengthened social support network at injury onset, or they might gain perspective on their injuries at the end of rehabilitation when they are transitioning back into sport.

In light of the dearth of longitudinal studies of positive psychological responses to sport injury, the main purpose of the current study is to examine longitudinally adversarial growth after a single type of injury—a torn anterior cruciate ligament (ACL)—using a multidimensional measure of adversarial growth. Use of a longitudinal research design afforded the opportunity to assess how adversarial growth unfolded after surgery, over the course of rehabilitation, and beyond. Although individuals may vary in terms of the rate and extent of their recovery from ACL tears and the surgery that typically follows, holding the type of injury constant helped reduce the variance in adversarial growth attributable to injury- and rehabilitation-related factors. ACL tears are a suitable type of injury to select for a study of adversarial growth for several reasons. In addition to the trauma of the injury, reconstructive surgery and its aftermath, which typically features a long (≥ 6 months) and sometimes painful rehabilitation and can include periodic setbacks and apprehension about

reinjury during the return to sport, can be substantial stressors and sources of negative emotions (Ardern, Kvist, & Webster, 2015; Carson & Polman, 2008; Heijne, Axelsson, Werner, & Biguet, 2008). Sport injuries in general (Brewer, 1993) and ACL injuries in particular (Brewer et al., 2010) constitute threats to the self-identity of athletes. Perceived adversarial growth has been documented after ACL tears (Rodenkirk, 1999) and other less severe injuries (Salim, Wadey, & Diss, 2015). Use of a multidimensional measure of adversarial growth allowed for a quantitative investigation of findings suggesting that temporal factors may play a role in the salience of various types of adversarial growth (Wadey et al., 2011). In light of the general lack of longitudinal changes in perceived benefits of experiencing threatening events outside the realm of sport (Tennen & Affleck, 2002), however, no hypotheses were advanced for the primary purpose of the study.

A secondary purpose of the current study was to examine the association between the magnitude of distress (in the form of pain and negative mood) experienced during the immediate postsurgical rehabilitation period, when pain and negative mood are at their peak (Morrey, Stuart, Smith, & Wiese-Bjornstal, 1999; Tripp, Stanish, Coady, & Reardon, 2004), and the amount of growth experienced after rehabilitation had ended. In accordance with the hypothesis of Galli and Vealey (2008) that agitation experienced after an adverse event may contribute to positive outcomes, it was predicted that pain and negative mood experienced during rehabilitation would be directly related to adversarial growth after rehabilitation had concluded.

Method

Participants

Participants were 108 ACL reconstructive surgery patients (72 men and 36 women) who ranged in age from 14 to 54 (M = 29.38, SD = 9.93) years. Participants were recruited from a sample of 109 consecutive patients who had ACL reconstruction surgery with one of the three orthopedic surgeons involved in the study and who were scheduled to complete their postoperative rehabilitation at one of the three physical therapy practices affiliated with the investigation (one patient who was eligible for the study declined to participate). According to the reports of participants, the sample was predominantly White (90%) and included a balance of competitive (47%) and recreational (49%) athletes, the vast majority of whom indicated that they had been injured during sport participation (80%). Participants reported involvement in a wide variety of individual and team sports, including soccer (22%), basketball (13%), American football (10%), and skiing (9%).

Measures

Questionnaires were used to obtain data pertaining to demographic and injury-related variables (e.g., age, gender, race/ethnicity, date of ACL injury, date of ACL surgery) and assess pain, negative mood, knee symptoms and functioning, and adversarial growth. Ratings of the average amount of pain that participants experienced on a given day were given on a numerical rating scale (NRS) that had endpoints of 0 (*no pain*) and 10 (*pain as bad as it can be*). Strong support has been obtained for the validity of numerical rating scales as indices of pain intensity (Jensen & Karoly, 2001), as evidenced by research showing, for

example, that they are strongly related to other indices of pain intensity (Jensen, Karoly, O'Riordan, Bland, & Burns, 1989), useful for documenting clinically important changes in pain intensity (Farrar, Young, LaMoreaux, Werth, & Poole, 2001; Salaffi, Stancati, Silvestri, Ciapetti, & Grassi, 2004), and sensitive to temporal changes in pain intensity after ACL surgery (Cupal & Brewer, 2001). Negative mood was assessed with a 9-item version of the Profile of Mood States—B (POMS-B) (Lorr & McNair, 1982) that has 3 items corresponding to each of 3 negative mood states (hostility, depression, and anxiety). Affleck, Tennen, Pfeiffer, and Fifield (1987) created the scale by selecting items from the POMS-B that were highly correlated with POMS-B total scores in a study of patients with rheumatoid arthritis. Item response options on the abbreviated POMS-B range from 0 (*very much unlike this*) to 3 (*very much like this*) (Affleck, Tennen, Urrows, & Higgins, 1992). Negative mood scores can, therefore, range from 0 to 27, with higher scores representing greater negative mood. In the current study, an alpha coefficient of .86 was found for the negative mood scale when administered to participants prior to surgery.

Knee symptoms and functioning, which were assessed to ensure that perceptions of growth were not simply reflections of improvements in knee status, were measured with the Knee Outcomes Survey—Sports Activities Scale (KOS-SAS; Borsa, Lephart, & Irrgang, 1998). The KOS-SAS is a 10-item self-report questionnaire with items that tap the extent to which knee symptoms such as pain, stiffness, swelling, and giving way affect: (a) respondents' sports activity involvement (e.g., "To what degree does pain in your knee affect your sports activity level?"); and (b) the extent to which respondents' ability to perform sport tasks such as running, jumping, and cutting is affected by their knee (e.g., "How does your knee affect your ability to jump and land on your involved leg?"). All items are scored on Likert type scales ranging from 0 to 5, with higher scores representing lesser impact of knee symptoms on sports activity involvement or greater ability to perform sport tasks. A 100-point (maximum) scale is created by summing the individual item scores and multiplying the total by 2. Correlations ranging from .67 to .87 have been obtained between KOS-SAS scores and those of similar knee scoring systems (Borsa et al., 1998). In the current study, a Cronbach's alpha coefficient of .91 was obtained for the KOS-SAS.

Adversarial growth was measured with the Posttraumatic Growth Inventory (PTGI; Tedeschi & Calhoun, 1996), a 21-item self-report instrument with subscales assessing 5 types of perceived benefits of experiencing stressful events: (a) new possibilities (5 items; e.g., "New opportunities are available which wouldn't have been otherwise."), (b) relating to others (7 items; e.g., "A sense of closeness with others."), (c) personal strength (4 items; e.g., "Knowing I can handle difficulties."), (d) spiritual change (2 items; e.g., "I have a stronger religious faith."), and (e) appreciation of life (3 items; e.g., "Appreciating each day."). Items are scored on a scale from 0 (*I did not experience this change as a result of my crisis*) to 5 (*I experienced this change to a very great degree as a result of my crisis.*). Higher scores on each subscale correspond to greater perceived growth in the particular domain covered by the subscale. Participants were instructed to complete the PTGI with respect to the degree to which the changes indicated in the items had occurred in their life as a result of their ACL injury and rehabilitation. Tedeschi and Calhoun presented evidence in support of the internal consistency and test-retest reliability of the PTGI and found that scores on all of the PTGI subscales with the exception of the one assessing spiritual change were higher among people

who had experienced severe trauma than those who had experienced no trauma. Subsequent investigations have provided further support for the factor structure of the PTGI (Linley, Andrews, & Joseph, 2007; Taku, Cann, Calhoun, & Tedeschi, 2008). Cronbach's alpha coefficients ranging from .83 to .90 were obtained for the PTGI subscales in the current study.

Procedure

The Institutional Review Board at the institution where the research was conducted approved the procedures used in this study. As part of a larger investigation of rehabilitation adherence, the study was carried out in compliance with the ethical standards delineated in the 1964 Declaration of Helsinki. Before they had ACL reconstruction surgery, participants (and their parent/guardian when appropriate) signed an informed consent document and completed a set of questionnaires that included items pertaining to demographic and injury-related information, the NRS, the abbreviated POMS-B, the KOS-SAS, and the PTGI. Participants were given 15 dollars for completing the preoperative battery.

At their first postoperative clinic-based physical therapy session, participants received 42 questionnaire booklets and 42 business reply (i.e., postage-paid) envelopes. The booklets included the NRS and the abbreviated POMS-B. Participants were instructed to complete the questionnaires at the end of each day and send them to the research team the next day through the mail. As an incentive to provide data on a daily basis, participants were paid one dollar for each questionnaire booklet that they mailed in and a bonus of seven dollars for each week in which they returned all seven booklets. A debriefing concluded the involvement of participants in the study.

At approximately 6, 12, and 24 months postsurgery, participants again completed the KOS-SAS and the PTGI. Participants were paid 15 dollars for each set of postoperative questionnaires that they completed.

Data Analysis

Aggregated measures of daily pain and daily negative mood were computed by averaging participants' daily pain and daily negative mood scores over the 42-day assessment period. A 6-week assessment window beginning directly after surgery was selected to include the challenges and pain of the immediate postoperative period and to ensure that the involvement of participants in supervised rehabilitation was covered by insurance. The data were inspected to determine whether the assumptions for parametric tests were met. Because PTGI subscale scores were uniformly positively skewed, the assumption of normality was not satisfied and nonparametric tests were used. Changes in PTGI subscale scores were examined in a series of Friedman tests. Significant χ^2 values were followed up with a series of Wilcoxon signed-rank tests. To examine the associations of daily pain, daily negative mood, and knee symptoms and functioning with adversarial growth after ACL surgery, Spearman's rank correlations were calculated among daily pain, daily negative mood, knee symptoms and functioning, and the PTGI subscales showing significant changes over the course of the study.

Given that nonparametric statistics were used to address the main research questions of the study, it was not possible to include covariates in the analyses. Nevertheless, because demographic, and sport-, and injury-related factors can affect psychological responses to sport injury (Wiese-Bjornstal et al., 1998), multiple series of Kruskal-Wallis tests and Spearman's rank correlation analyses were conducted to assess the bivariate associations between the PTGI subscales (assessed postoperatively) and variables assessed preoperatively that could conceivably have served as covariates if it had been possible to use parametric statistics (i.e., age, gender, type of sport, level of sport involvement, time since injury).

Results

Of the 108 participants in the study, 91 agreed to complete daily self-reports for 42 days during rehabilitation. Of the 3,822 booklets that were distributed, participants returned 3,628 (95%) of them. The number of participants who completed the PTGI at the preoperative and postoperative assessments ranged from 81 to 107. Means and standard deviations of the measured variables for participants with complete PTGI responses at all four data collection points are presented in Table 1. Item means ranged from 1.05 to 1.42 for the relating to others subscale, 0.83 to 1.04 for the new possibilities subscale, 1.35 to 1.78 for the personal strength subscale, 0.44 to 0.65 for the spiritual change subscale, and 1.31 to 1.58 for the appreciation of life subscale. These values correspond to participants reporting that their ACL injury and rehabilitation prompted changes that were predominantly from "a very small degree" to "a small degree." The modal response for all PTGI subscales at all preoperative and postoperative assessments was zero, corresponding to participants' reports of no change due to their ACL injury and rehabilitation.

The Friedman tests yielded significant χ^2 values for the relating to others, $\chi^2(3, N = 62) = 16.00$, $p = .001$, personal strength, $\chi^2(3, N = 62) = 11.54$, $p = .009$, and spiritual change, $\chi^2(3, N = 62) = 8.68$, $p = .03$, subscales. The χ^2 values for the new possibilities, $\chi^2(3, N = 62) = 4.69$, $p = .20$, and appreciation for life, $\chi^2(3, N = 62) = 3.00$, $p = .39$, subscales were not statistically significant. Wilcoxon signed-rank tests performed on the relating to others subscale scores indicated that there was a significant increase in this form of adversarial growth from the preoperative assessment to the 6-month postsurgery assessment, $Z = 2.05$, $p = .04$, and did not change significantly for the remaining two assessments, both Zs < .33 and ps >.74. The 12- and 24-month postsurgery values for relating to others were both significantly higher than those for the preoperative assessment, both Zs > 2.34 and ps < .02. As with the relating to others subscale, Wilcoxon signed-rank tests performed on the personal strength subscale scores indicated that there was a significant increase in this form of adversarial growth from the preoperative assessment to the 6-month postsurgery assessment, $Z = 2.19$, $p = .03$, and did not change significantly for the remaining two assessments, both Zs < .94 and ps >.34. The 12-month postsurgery values for personal strength were significantly higher than those for the preoperative assessment, $Z = 2.34$, $p < .02$, but the 24-month postsurgery values for personal strength did not differ from those for the preoperative assessment, $Z = 1.84$, $p = .07$. Wilcoxon signed-rank tests performed on the spiritual change subscale scores revealed a pattern of results that differed from that for the relating to others and personal strength subscales. There was a significant increase in spiritual change scores from the preoperative assessment to the 6-month postsurgery

assessment, $Z = 2.27$, $p = .02$; but scores decreased significantly to preoperative levels for the remaining two assessments, both Zs > 2.24 and ps <.03 in relation to the 6-month assessment and both Zs < .58 and ps > .56 in relation to the preoperative assessment.

Spearman's rank correlations of daily pain, daily negative mood, and KOS-SAS scores with scores on the PTGI subscales showing significant changes over the course of the study (i.e., relating to others, personal strength, and spiritual change) are displayed in Table 2. A clear pattern of positive associations of both daily pain and daily negative mood with the PTGI relating to others and personal strength subscales and either daily pain or daily negative mood with the PTGI spiritual change subscale through 12 months postsurgery. By 24 months postsurgery, significant associations with adversarial growth were found only for daily pain, which was positively associated with the PTGI relating to others and personal strength subscales. No significant correlations were found between the KOS-SAS and the PTGI subscales at any of the three postoperative assessments.

There were no significant differences in the Kruskal-Wallis tests comparing the PTGI subscale scores of men and women across the three postoperative assessments. The series of Kruskal-Wallis tests comparing competitive and recreational athletes on the 5 PTGI subscales across the three postoperative assessments revealed only one significant difference (with competitive athletes higher than recreational athletes on the new possibilities subscale at the 24-month assessment, $p = .01$). In the Kruskal-Wallis tests comparing participants on the PTGI subscales by type of sport, participants who indicated that they were involved in team sports ($n = 73$) had significantly higher scores than those who indicated that they were involved in individual sports ($n = 31$) on the relating to others ($p = .04$), new possibilities ($p = .04$), and personal strength ($p = .001$) subscales at 6 months postsurgery and the personal strength subscale ($p = .01$) at 24 months postsurgery. Spearman's rank correlation analyses revealed that age and the number of days elapsed between the preoperative assessment and surgery were signficantly correlated with none of the PTGI subscales at any of the three postoperative assessments. Number of days elapsed between ACL injury and the respective 6-, 12-, and 24-month postoperative assessments of the PTGI subscales was signficantly correlated only with the spiritual change subscale at the 12-month assessment ($\rho = -.24$, $p = .03$).

Discussion

This study is the first of which we know to explicitly investigate positive psychological consequences of sport injury longitudinally. Although the study is not prospective with respect to injury occurrence, all participants were assessed on adversarial growth prior to ACL reconstruction surgery and rehabilitation, thereby providing a baseline for examining patterns of adversarial growth over time. Use of a validated multidimensional measure of adversarial growth allowed for differentiation of various aspects of adversarial growth, and assessment of daily pain and negative mood over the first 6 weeks of rehabilitation provided an opportunity to examine prospective associations between adversity during rehabilitation and subsequent adversarial growth.

From a descriptive point of view, the most striking finding is the low levels of adversarial growth reported by participants. Taken together, an ACL tear, reconstructive surgery, and several months of postoperative rehabilitation would certainly seem to constitute a stressor of sufficient magnitude and duration to precipitate growth to a greater extent than that observed in the current study. It is possible that the sheer prevalence of ACL injuries coupled with advances in surgery and rehabilitation have normalized the injury and its sequelae to the point that it is viewed as a circumstance to cope with and move on from rather than as an opportunity for growth. Of course, this speculation requires empirical validation.

Despite the general lack of adversarial growth reported by participants, detectable changes were observed for multiple aspects of adversarial growth. Perceptions of growth in relating to others and personal strength increased from prior to surgery to 6 months after surgery and remained elevated through the 2-year assessment. Perceived growth in interpersonal relations and mental resolve have been documented in previous research on perceived benefits of injury (e.g., Galli & Reel, 2012b; Galli & Vealey, 2008; Podlog & Eklund, 2006; Rodenkirk, 1999; San José, 2003; Tracey, 2003; Udry et al., 1997; Wadey et al., 2013; Wadey, et al., 2011) and other sport-related forms of adversity (Galli & Reel, 2012a). Perceptions of spiritual change, however, were more ephemeral, increasing from the preoperative assessment to the 6-month assessment, but decreasing to presurgery levels thereafter. It is unclear why perceived spiritual change would diminish after the 6-month assessment, but it may have something to do with the fact that the most rapid and dramatic improvements in recovery occur during the first 6 months after ACL reconstruction. Spiritual change has not been a common theme among participants in previous studies of positive psychological responses to sport injury, so this form of adversarial growth may be more temporally-bound to the salient adversity-related features of ACL injury, surgery, and rehabilitation than the relating to others and personal strength aspects of adversarial growth. The patterns of means for the new possibilities and appreciation for life subscales were similar to those for the relating to others and personal strength subscales, but the trends were not strong enough to achieve statistical significance. Unlike perceiving spiritual change, perceiving new possibilities and having greater appreciation of life are frequently cited as psychological benefits of sport injury (e.g., Galli & Reel, 2012b; Galli & Vealey, 2008; Podlog & Eklund, 2006; Rodenkirk, 1999; San José, 2003; Tracey, 2003; Udry et al., 1997; Wadey et al., 2013; Wadey et al., 2011), so a study with greater statistical power might yield different results for these two variables.

Although it was not possible to examine the independent contributions of daily pain and negative mood to the prediction of adversarial growth while statistically controlling for improvement in knee symptoms and functioning, nonparametric statistics yielded a consistent set of significant prospective associations between the daily measures and the relating to others and personal strength subscales over the first 12 months postsurgery. These associations, when coupled with the nonsignificant concurrent correlations of knee symptoms and functioning with adversarial growth over the full duration of the study, suggest that the adversarial growth reported by participants after surgery was not simply a function of improved knee symptoms and functioning and that distress during ACL rehabilitation is positively related to subsequent reports of adversarial growth. The positive association between adversity (in the forms of pain and negative mood) and adversarial

growth is consistent with findings from studies examining stressors other than injury (Armeli et al., 2001; Park et al., 1996; Tedeschi & Calhoun, 1996) and a sport-specific model of positive responses to adversity in which agitation can have adaptive value (Galli & Vealey, 2008). Further research is needed to gain an understanding of how pain and negative mood reported during rehabilitation might translate into perceptions of psychological growth 10 or more months later. Consistent with contemporary models of growth through adversity (e.g., functional-descriptive model, organismic valuing theory, affective-cognitive processing model), a thorough examination of the process of appraising and coping with the stressors encountered after ACL surgery would be a logical next step for investigators.

With the exception of type of sport (i.e., team versus individual), there were few significant bivariate associations between selected demographic and sport- and injury-related variables and the PTGI subscales at the three postoperative assessments. It is unclear why team sport athletes would report greater adversarial growth after ACL surgery than individual sport athletes. One possibility is that social support provided by teammates when athletes are early in the return to sport after ACL surgery and rehabilitation (i.e., the 6-month assessment) fosters cognitive appraisals of the situation that are compatible with perceptions of growth. Such an interpretation, which is consistent with the integrated model of psychological response to sport injury (Wiese-Bjornstal et al., 1998), warrants further investigation. The general lack of significant associations between the other five demographic-, sport-, and injury-related variables (i.e., age, gender, level of sport involvement, time between injury and the preoperative assessment, time since injury) and the PTGI subscales at any of the three postoperative assessments does not mean that these variables do not play a role in perceived adversarial growth after ACL surgery. Rather, one or more of these factors may emerge as important in a multivariate analytical context with criterion measures that are less skewed and have greater response variability than the PTGI subscales did in the current study.

A primary limitation of the current study should be taken into account when considering the results. Specifically, because adversarial growth was assessed exclusively with a self-report questionnaire, it is not possible to determine the extent to which postoperative changes in perceived adversarial growth reflected actual (i.e., veridical) changes in cognition and behavior. Although coaches have observed changes in athletes with injury similar to those documented in the current study (Wadey et al., 2013), people’s reports of adversarial growth are suspect (Tennen & Affleck, 2009) and do not necessarily correspond to longitudinal changes in aspects where growth is purported to occur (Frazier et al., 2009). That the majority of participants in the current study reported that they experienced little or no growth as a result of their ACL injury and rehabilitation raises the interesting possibility that some participants may have grown psychologically from their ACL-related experiences without realizing (and subsequently reporting) it. Consequently, as suggested by Wadey et al. (2013), behavioral indicators of adversarial growth should be included in future research to examine both perceived and actual adversarial growth over the course of rehabilitation. For example, the interpersonal behavior of participants could be observed and coded as a companion to the PTGI relating to others subscale.

Overall, the findings indicate that ACL injury, surgery, and rehabilitation generally do not appear to be events that promote perceptions of adversarial growth. Most participants did not report having grown substantially, but those who did were more likely to have reported having experienced pain and negative mood to a greater extent during the rehabilitation period. Relating to others and personal strength were the areas in which enduring elevations in adversarial growth were reported, with perceived spiritual change occurring on a temporary basis. Through use of a longitudinal research design, the current study advances knowledge of positive psychological responses to injury. With further understanding of adversarial growth following sport injury, including the circumstances under which athletes with injuries are and are not likely to report experiencing growth, clinicians will be better positioned to foster growth in the athletes with whom they work.

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References

Affleck G, Tennen H, Pfeiffer C, Fifield J. Appraisals of control and predictability in adapting to a chronic disease. Journal of Personality and Social Psychology. 1987; 53:273–279. DOI: 10.1037/0022-3514.53.2.273 [PubMed: 3625467]

Affleck G, Tennen H, Urrows S, Higgins P. Neuroticism and the pain-mood relation in rheumatoid arthritis: Insights from a prospective daily study. Journal of Consulting and Clinical Psychology. 1992; 60:119–126. DOI: 10.1037/0022-006X.60.1.119 [PubMed: 1556274]

Ardern CL, Kvist J, Webster KE. Psychological aspects of anterior cruciate ligament injuries. Operative Techniques in Sports Medicine. 2015; doi: 10.1053/j.otsm.2015.09.006

Armeli S, Gunthert KC, Cohen LH. Stressor appraisals, coping, and post-event outcomes: The dimensionality and antecedents of stress-related growth. Journal of Social & Clinical Psychology. 2001; 20:366–395. DOI: 10.1521/jscp.20.3.366.22304

Borsa PA, Lephart SM, Irrgang JJ. Sport-specificity of knee scoring systems to assess disability in anterior cruciate ligament-deficient athletes. Journal of Sport Rehabilitation. 1998; 7:44–60.

Brewer BW. Self-identity and specific vulnerability to depressed mood. Journal of Personality. 1993; 61:343–364. DOI: 10.1111/j.1467-6494.1993.tb00284.x [PubMed: 8246106]

Brewer BW, Cornelius AE, Stephan Y, Van Raalte JL. Self-protective changes in athletic identity following ACL reconstruction. Psychology of Sport and Exercise. 2010; 11:1–5. DOI: 10.1016/j.psychsport.2009.09.005 [PubMed: 20161402]

Calhoun, LG., Cann, A., Tedeschi, RG. The post-traumatic growth model: Sociocultural considerations. In: Weiss, T., Berger, R., editors. Posttraumatic growth and culturally competent practice: Lessons learned from around the globe. Hoboken, NJ: Wiley; 2010. p. 1-14.

Calhoun, LG., Tedeschi, RG. Posttraumatic growth: Future directions. In: Tedeschi, RG.Park, CL., Calhoun, LG., editors. Posttraumatic growth: Theory and research on change in the aftermath of crisis. Mahwah, NJ: Erlbaum; 1998. p. 215-238.

Carson F, Polman RCJ. ACL injury rehabilitation: A psychological case study of a professional rugby union player. Journal of Clinical Sport Psychology. 2008; 2:71–90.

Cupal DD, Brewer BW. Effects of relaxation and guided imagery on knee strength, reinjury anxiety, and pain following anterior cruciate ligament reconstruction. Rehabilitation Psychology. 2001; 46:28–43. DOI: 10.1037/0090-5550.46.1.28

Evans L, Wadey R, Hanton S, Mitchell I. Stressors experienced by injured athletes. Journal of Sports Sciences. 2012; 30:917–927. DOI: 10.1080/02640414.2012.682078 [PubMed: 22551525]

Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical rating scale. Pain. 2001; 94:149–158. DOI: 10.1016/S0304-3959(01)00349-9 [PubMed: 11690728]

Frazier P, Tennen H, Gavian M, Park C, Tomich P, Tashiro T. Does self-reported posttraumatic growth reflect genuine positive change? Psychological Science. 2009; 20:912–919. DOI: 10.1037/a0019894 [PubMed: 19515115]

Galli N, Reel JJ. Can good come from bad? An examination of adversarial growth in Division I NCAA athletes. Journal of Intercollegiate Sport. 2012a; 5:199–212.

Galli N, Reel JJ. 'It was hard, but it was good': A qualitative exploration of stress-related growth in Division I intercollegiate athletes. Qualitative Research in Sport, Exercise and Health. 2012b; 4:297–319.

Galli N, Vealey RS. "Bouncing back" from adversity: Athletes' experiences of resilience. The Sport Psychologist. 2008; 22:316–335.

Heijne A, Axelsson K, Werner S, Biguet G. Rehabilitation and recovery after anterior cruciate ligament reconstruction: Patients' experiences. Scandinavian Journal of Medicine & Science in Sports. 2008; 18:325–335. DOI: 10.1111/j.1600-0838.2007.00700.x [PubMed: 18067526]

Howells K, Fletcher D. Sink or swim: Adversity- and growth-related experiences in Olympic swimming champions. Psychology of Sport and Exercise. 2015; 16:37–48. DOI: 10.1016/j.psychsport.2014.08.004

Jensen, MP., Karoly, P. Self-report scales and procedures for assessing pain in adults. In: Turk, DC., Melzack, R., editors. Handbook of pain assessment. 2. New York, NY: Guilford Press; 2001. p. 15-34.

Jensen MP, Karoly P, O'Riordan EF, Bland F Jr, Burns RS. The subjective experience of acute pain. An assessment of the utility of 10 indices. Clinical Journal of Pain. 1989; 5:153–159. DOI: 10.1097/00002508-198906000-00005 [PubMed: 2520397]

Joseph S, Linley A. Positive adjustment to threatening events: An organismic valuing theory of growth through adversity. Review of General Psychology. 2005; 9:262–280. DOI: 10.1037/1089-2680.9.3.262

Joseph S, Linley PA. Growth following adversity: Theoretical perspectives and implications for clinical practice. Clinical Psychology Review. 2006; 26:1041–1053. DOI: 10.1016/j.cpr.2005.12.006 [PubMed: 16473442]

Joseph S, Murphy D, Regel S. An affective-cognitive processing model of post-traumatic growth. Clinical Psychology & Psychotherapy. 2012; 19:316–325. DOI: 10.1002/cpp.1798 [PubMed: 22610981]

Leddy MH, Lambert MJ, Ogles BM. Psychological consequences of athletic injury among high-level competitors. Research Quarterly for Exercise and Sport. 1994; 65:347–354. DOI: 10.1080/02701367.1994.10607639 [PubMed: 7886284]

Linley PA, Andrews L, Joseph S. Confirmatory factor analysis of the Posttraumatic Stress Inventory. Journal of Loss and Trauma. 2007; 10:83–96. DOI: 10.1080/15325020601162823

Linley PA, Joseph S. Positive change following trauma and adversity: A review. Journal of Traumatic Stress. 2004; 17:11–21. [PubMed: 15027788]

Lorr, M., McNair, D. Profile of Mood States—B. San Diego: Educational and Industrial Testing Service; 1982.

Martens MP, Dams-O'Connor K, Beck NC. A systematic review of college student-athlete drinking: Prevalence rates, sport-related factors, and interventions. Journal of Substance Abuse Treatment. 2006; 31:305–316. DOI: 10.1016/j.jsat.2006.05.004 [PubMed: 16996393]

McMillen JC, Fisher RH. The Perceived Benefits Scale: Measuring perceived positive life changes after negative events. Social Work Research. 1998; 22:173–186. DOI: 10.1093/swr/22.3.173

Morrey MA, Stuart MJ, Smith AM, Wiese-Bjornstal DM. A longitudinal examination of athletes' emotional and cognitive responses to anterior cruciate ligament injury. Clinical Journal of Sport Medicine. 1999; 9:63–69. [PubMed: 10442619]

Nietzsche, F. The twilight of the idols and the anti-Christ: Or how to philosophize with a hammer. Hollingdale, RJ., translator. New York: Penguin Classics; 1990.

Park CL, Cohen LH, Murch RL. Assessment and prediction of stress-related growth. Journal of Personality. 1996; 64:71–105. DOI: 10.1111/j.1467-6494.1996.tb00815.x [PubMed: 8656319]

Petitpas, AJ., Danish, SJ. Caring for injured athletes. In: Murphy, SM., editor. Sport psychology interventions. Champaign, IL: Human Kinetics; 1995. p. 255-281.

Podlog L, Eklund RC. A longitudinal investigation of competitive athletes' return to sport following serious injury. Journal of Applied Sport Psychology. 2006; 18:44–68. DOI: 10.1080/10413200500471319

Rodenkirk, BJ. Unpublished master's thesis. California State University; Fullerton, CA: 1999. Psychological reactions to season-ending anterior cruciate ligament injuries among elite collegiate athletes.

Salaffi F, Stancati A, Silvestri CA, Ciapetti A, Grassi W. Minimal clinically important changes in chronic musculoskeletal pain intensity measured on a numerical rating scale. European Journal of Pain. 2004; 8:283–291. DOI: 10.1016/j.ejpain.2003.09.004 [PubMed: 15207508]

Salim J, Wadey R, Diss C. Examining the relationship between hardiness and perceived stress-related growth in a sport injury context. Psychology of Sport and Exercise. 2015; 19:10–17. DOI: 10.1016/j.psychsport.2014.12.004

San José A. Injury of elite athletes: Sport- and gender- related representations. International Journal of Sport and Exercise Psychology. 2003; 1:434–459.

Shuer ML, Dietrich MS. Psychological effects of chronic injury in elite athletes. Western Journal of Medicine. 1997; 166:104–109. [PubMed: 9109326]

Smith AM, Milliner EK. Injured athletes and the risk of suicide. Journal of Athletic Training. 1994; 29:337–341. [PubMed: 16558297]

Sundgot-Borgen J. Risk and trigger factors for the development of eating disorders in female elite athletes. Medicine and Science in Sports and Exercise. 1994; 26:414–419. [PubMed: 8201895]

Taku K, Cann A, Calhoun LG, Tedeschi RG. The factor structure of the Posttraumatic Growth Inventory: A comparison of five models using confirmatory factor analysis. Journal of Traumatic Stress. 2008; 21:158–164. DOI: 10.1002/jts.20305 [PubMed: 18404631]

Tedeschi, RG., Calhoun, LG. Trauma & transformation: Growing in the aftermath of suffering. Thousand Oaks, CA: Sage; 1995.

Tedeschi RG, Calhoun LG. The Post-Traumatic Growth Inventory: Measuring the positive legacy of trauma. Journal of Traumatic Stress. 1996; 9:455–471. DOI: 10.1007/BF02103658 [PubMed: 8827649]

Tedeschi RG, Calhoun LG. Posttraumatic growth: Conceptual foundations and empirical evidence. Psychological Inquiry. 2004; 15:1–18. DOI: 10.1207/s15327965pli1501_01

Tennen, H., Affleck, G. Benefit-finding and benefit-reminding. In: Snyder, CR., Lopez, SJ., editors. Handbook of positive psychology. New York: Oxford University Press; 2002. p. 584-597.

Tennen, H., Affleck, G. Assessing positive life change: In search of meticulous methods. In: Park, CL.Lechner, SC.Antoni, MH., Stanton, AL., editors. Medical illness and positive life change: Can crisis lead to personal transformation?. Washington, DC: American Psychological Association; 2009. p. 584-597.

Tracey J. The emotional response to the injury and rehabilitation process. Journal of Applied Sport Psychology. 2003; 15:279–293. DOI: 10.1080/714044197

Tripp DA, Stanish WD, Coady C, Reardon G. The subjective pain experience of athletes following anterior cruciate ligament surgery. Psychology of Sport and Exercise. 2004; 5:339–354. DOI: 10.1016/S1469-0292(03)00022-0

Udry E, Gould D, Bridges D, Beck L. Down but not out: Athlete responses to season-ending injuries. Journal of Sport & Exercise Psychology. 1997; 19:229–248.

Wadey R, Clark S, Podlog L, McCullough D. Coaches' perceptions of athletes' stress-related growth following sport injury. Psychology of Sport and Exercise. 2013; 14:125–135. DOI: 10.1016/j.psychsport.2012.12.005

Wadey R, Evans L, Evans K, Mitchell I. Perceived benefits following sport injury: A qualitative examination of their antecedents and underlying mechanisms. Journal of Applied Sport Psychology. 2011; 23:142–158. DOI: 10.1080/10413200.2010.543119

Wadey R, Podlog L, Galli N, Mellalieu SD. Stress-related growth following sport injury: Examining the applicability of the organismic valuing theory. Scandinavian Journal of Medicine and Science in Sports. 2016; 26:1132–1139. DOI: 10.1111/sms.12579 [PubMed: 26589377]

Wiese-Bjornstal DM, Smith AM, Shaffer SM, Morrey MA. An integrated model of response to sport injury: Psychological and sociological dimensions. Journal of Applied Sport Psychology. 1998; 10:46–69. DOI: 10.1080/10413209808406377

Table 1

Means and Standard Deviations of Daily Pain, Daily Negative Mood, Posttraumatic Growth Inventory (PTGI) Subscales, and Knee Outcomes Survey – Sports Activity Scale (KOS-SAS) Before Surgery and at 6-, 12-, and 12-Months After Surgery

	Before surgery		6-months		12-months		24-months	
Variable	***M***	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
PTGI – relating to others	14.35	8.14	16.76	9.37	16.22	7.88	16.95	8.62
PTGI – new possibilities	9.13	5.66	10.05	5.94	10.05	5.18	10.21	6.19
PTGI – personal strength	9.39	5.76	11.11	5.79	10.90	5.14	11.13	5.89
PTGI – spiritual change	2.94	2.22	3.29	2.18	2.87	1.65	2.92	1.84
PTGI – appreciation of life	6.92	4.18	7.73	4.19	7.55	3.70	7.74	4.35
KOS-SAS	44.87	24.73	77.38	18.23	85.83	10.71	87.49	11.62

Note. Means and standard deviations are for participants who had complete PTGI responses at all four data collection points ($n = 62$). For the PTGI subscales, the potential ranges of scores were 0–35 for relating to others, 0–25 for new possibilities, 0–20 for personal strength, 0–10 for spiritual change, and 0–15 for appreciation of life. The potential range of scores for the KOS-SAS is 0–100.

Table 2

Spearman's Rank Correlations of Daily Pain, Daily Negative Mood, and KOS-SAS Scores with PTGI Relating to Others, Personal Strength, and Spiritual Change Subscale Scores at 6-, 12-, and 12-Months After Surgery

Variable	Daily Pain	Daily Negative Mood	KOS-SAS
PTGI – relating to others			
6-months	.25*	.26*	.04
12-months	.29*	.25*	−.17
24-months	.27*	.19	.08
PTGI – personal strength			
6-months	.25*	.28*	.22
12-months	.33**	.32**	−.08
24-months	.27*	.20	−.03
PTGI – spiritual change			
6-months	.15	.31*	−.11
12-months	.26*	.14	.01
24-months	.17	.21	−.04

n = 76–85;

* $p < .05$;

** $p < .005$