Published in final edited form as:

Hand Clin. 2016 February ; 32(1): 33–39. doi:10.1016/j.hcl.2015.08.005.

Pain Psychology and Pain Catastrophizing in the Perioperative Setting: A review of impacts, interventions and unmet needs

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Abstract

The purpose of this article is to provide a brief overview of the literature on perioperative pain psychology in terms of relevant factors and treatments. Where possible, the content emphasizes hand surgery or hand trauma populations—though this literature is notably limited—as well as the relevant musculoskeletal surgery literature. Finally, gaps in understanding and patient care are identified and discussed.

Keywords

pain psychology; psychological; outcomes; catastrophizing; perioperative; surgical; surgery

Introduction

It has long been known that surgical outcomes are influenced by the medical complexity of the patient. An accumulation of evidence similarly demonstrates that psychological factors impact post-surgical outcomes, thus setting the stage for the integration of psychology into models of care. Within the context of psychology, pain-specific psychological factors have emerged as particularly powerful determinants of post-surgical outcomes, at times surpassing medical characteristics or surgical variables in their predictive value. In the perioperative setting, pain is a highly salient stimulus, and psychological reactions to pain directly influence the patient experience and their response to medical treatment. Accordingly, in an era of patient-centered care that focuses on cost-containment and optimizing outcomes, there has been a surge of interest in the psychology of surgical patients, with a particular focus on pain psychology.

The purpose of this article is to provide a brief overview of the literature on perioperative *pain psychology* in terms of relevant factors and treatments. Where possible, the content

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The author discloses no financial conflicts of interest.

emphasizes hand surgery or hand trauma populations—though this literature is notably limited—as well as the relevant musculoskeletal surgery literature. Finally, gaps in understanding and patient care are identified and discussed.

In the perioperative setting, the most-studied psychological factors related to pain include pain-related anxiety, general anxiety, depression, post-traumatic stress disorder, and pain catastrophizing. While all of these psychological factors are known to correlate with pain, pain-related anxiety and pain catastrophizing are distinctly specific to the experience of pain. Pain catastrophizing is a negative mental set brought to bear in the context of actual or anticipated pain [1]. Pain catastrophizing is typically measured with the catastrophizing subscale of the Coping Skills Questionnaire [2] or with the 13-item Pain Catastrophizing Scale [3]. The Pain Catastrophizing Scale contains 3 subscales: magnification of pain, rumination of pain, or feelings of helpless about pain. Catastrophizing is a form of pain-specific psychological distress and it powerfully predicts outcomes for pain, including chronic pain intensity [4], post-surgical pain intensity [5–7], disability [4], poor response to opioids [8], greater use of perioperative opioids [5], misuse of opioids [9], persistent use of opioids 2 months after surgery [10], and persistent post-surgical pain at 4 month follow-up [11]. In outpatient chronic pain samples, research suggests that pain catastrophizing has greater predictive value for treatment outcomes than disease characteristics, pain intensity, or various medical interventions [9, 12–14]. A vast and varied literature has described pain catastrophizing in outpatient chronic pain. However, the number of studies that have investigated pain catastrophizing in the perioperative context remains relatively small.

Pain-related psychological factors and musculoskeletal surgery outcomes

Two systematic reviews have examined pain-related psychological predictors and correlates for chronic post-surgical pain. The first was a meta-analysis of 29 studies that examined pre-operative anxiety and pain catastrophizing in patients with a post-surgical follow-up between 3 and 12 months (N=6628) [15]. Eighteen of the studies (N=4963) involved musculoskeletal surgery, one of which involved shoulder surgery [16], and none involved hand surgery. The authors of the review noted the typical limitations of cross study comparison with variability of constructs measured and instruments used. The types of anxiety assessed across studies varied and included state and trait anxiety, kinesiophobia (fear of movement), fear of pain, and pain-related anxiety. In general, kinesiophobia was not found to be a significant predictor of chronic post-surgical pain. However, the authors reported at least moderate evidence that preoperative anxiety and pain catastrophizing were associated with the development of post-surgical chronic pain. Pain catastrophizing emerged as the strongest predictor of chronic post-surgical pain; with a maximum pooled effect size of 2.37 based on 15 studies that including 5046 patients.

The effect of psychological factors on likelihood for post-surgical chronic pain was greater in musculoskeletal surgeries compared to other surgery types (67% vs 36%, respectively). The authors speculated this might be due to greater incidence of pre-surgical chronic pain—a known risk factor for post-surgical chronic pain—in the musculoskeletal surgery population. The majority of studies reported a direct association between psychological factors and chronic post-surgical pain, and no studies found reverse associations. While

results were not uniform (45% of studies found no association with psychological factors and surgical outcome) musculoskeletal surgery studies reported greater positive associations.

Total hip and knee arthroplasty are the most studied surgeries in regards to pain. A systematic review examined psychological factors affecting outcomes in total hip and knee arthroplasty [17]. The review included prospective studies with a minimum 6-week post-surgical follow-up time point. The final analysis was conducted on 35 studies, and pain catastrophizing was the only pain-specific psychological construct assessed. The authors concluded that low pre-operative mental health and pain catastrophizing negatively impacted surgical outcomes. In particular, the strongest evidence was found for the direct relationship between pain catastrophizing and post-surgical pain in total knee arthroplasty. Only one study in the review quantified the association with an odds ratio. In this study, controlling for confounding factors, patients with greater pre-operative pain catastrophizing had greater likelihood for poor outcome (OR = 2.67; 95% confidence interval 1.2; 6.1). The outcome was defined as chronic post-surgical pain—operationalized as <50 percent improvement on the pain subscale of the Western Ontario and McMaster Universities Arthritis Index (WOMAC) [18] at 6 month follow-up[19].

Two additional studies are specifically discussed below because they were conducted recently and therefore not included in the previously mentioned systematic reviews.

In the first study, researchers examined psychological factors following musculoskeletal trauma and fracture in 152 patients [20]. Of all the factors assessed, pain catastrophizing best accounted for the variance in pain intensity and disability after skeletal trauma, controlling for depression and pain-related anxiety (measured with the Pain Anxiety Symptom Scale-20)[21]. While pain catastrophizing was the strongest overall predictor of musculoskeletal trauma outcomes, pain-related anxiety was also a significant predictor of disability in the early recovery phase (1–2 months after trauma). The same study sample was used for a separate study that examined risk factors for persistent opioid use 1–2 months after surgery for musculoskeletal surgery [10]. Pain catastrophizing was revealed to best predict reported persistent opioid use. Using logistic regression modeling and controlling for the injury, the surgical procedure and the surgeon, the authors reported that pain catastrophizing accounted for 23% of the variance in prolonged opioid use after surgery.

Hand Surgery

While the literature remains limited in hand surgery, accumulating evidence supports the impact of pain psychology in hand surgery outcomes, and in general findings align well with those from the total knee arthroplasty meta-analyses described above. In a recent study, researchers investigated surgical recovery in 116 patients who underwent open reduction and internal fixation for a distal radius fracture [22]. In this prospective cohort study they examined whether demographic, injury characteristics, or psychological variables were related with distance to palmar crease (finger stiffness) at suture removal and 6-weeks after surgery. Multiple variables—including pain catastrophizing— were associated with increased distance to palmar crease at suture removal. However, at 6 week post-surgical follow-up,

pain catastrophizing was the only variable associated with increased distance to palmar crease, thus pointing to delayed surgical recovery as indexed by finger motion.

In another recent prospective study, Roh and colleagues conducted a prospective study on 121 patients undergoing surgery for distal radius fracture [23]. At 4 weeks post surgery, pre-operative pain-related anxiety and pain catastrophizing were significantly associated with worse outcomes: decreased wrist range of motion and grip strength. Furthermore, the association for pain-related anxiety and delayed recovery persisted at 3 months but was no longer significant at 6 month follow-up. These findings were similar to knee surgery, and suggest that early recovery after hand surgery is significantly impacted by pain-related anxiety and pain catastrophizing. The authors concluded that post-surgical outcomes may be improved by assessing and treating these factors in high-risk patients early in the *recovery process*. Perhaps additional benefit may be derived from brief *pre-surgical* psychological treatment as it may assist the patient in decreasing anticipatory anxiety related to the surgical procedure itself. Furthermore, brief psychological treatment delivered 1–2 weeks prior to surgery would theoretically allow many patients sufficient time to encode relevant information and acquire familiarity and basic proficiency with the cognition, emotion, and physiologic regulation skills.

Several factors merit consideration with surgical candidates. First, many patients will have pain prior to surgery, possibly even chronic pain. Patients also have individual, established patterns of responses to pain that includes pain beliefs, cognitions, emotions and behaviors. For instance, in hand fracture patients, catastrophizing was found to predict current pain, and pain-related anxiety predicted task-related pain even after controlling for injury-related variables [24]. Given that pain is an important consideration in surgical treatment, it is possible that pain catastrophizing may speed the path to surgery while simultaneously undermining surgical response. Other work has shown that post-surgical acute pain is predicted by psychological factors, including anxiety [7], depression, and pain catastrophizing [7]. In short, pain-related psychological factors – how the patient *responds* to their pain – are predictive for pain outcomes across the continuum of injury and care.

Most of the literature attempts to distinguish patients who improve after surgery from those who do not. Less studied are the predictors for who gets *worse* after musculoskeletal surgery. One prospective study examined predictors of chronic post-surgical pain in 50 adolescents undergoing spine surgery [25]. The authors found that 6 months after surgery 22 percent of the sample evidenced pain intensity that was at or worse than their baseline pre-surgical pain intensity, and that these poor surgical results were predicted by pre-surgical anxiety and low pain self-efficacy (catastrophizing was not measured). The findings suggest highlight the importance of addressing psychological factors such as anxiety to attempt to mitigate chronic post-surgical pain.

Pain self-efficacy was recently studied in 120 patients undergoing 1 of 3 types of minor hand surgery: carpal tunnel syndrome, trigger finger, or benign tumor resection [26]. This study found a significant correlation between post-surgical pain intensity with pain catastrophizing, pain anxiety, and pain self-efficacy. Multivariate analyses revealed that after controlling for all factors, depression emerged as the sole significant predictor of

function [26], as indexed by scores on the Disabilities of the Arm, Shoulder and Hand (DASH)[27]. At least two points merit consideration regarding the disparate findings from these 2 studies. First, the surgical samples are divergent in location and medical complexity (spine surgery vs. minor hand surgery). Second, when considering pre-surgical psychological variables of interest it is important to note that there is considerable shared variance. These inconsistencies in literature show the importance of sample characteristics and variability in study designs all of which must be considered consideration when interpreting findings and comparing study results.

Practical Implications & Treatments

In aggregate, the evidence suggests that psychological factors contribute substantially to surgical outcomes. A logical question is whether the variables can be modified to improve outcomes. The psychological component to treating pain includes an array of approaches to improve cognition and emotion regulation. Such approaches include Mindfulness Based Stress Reduction (MBSR), Cognitive Behavioral Therapy (pain-CBT), Acceptance and Commitment Therapy, meditation, pain education, relaxation, hypnosis, or some combination of these approaches. In the outpatient setting, treatment typically involves 8–12 treatment sessions that are delivered individually or in group settings (classes). As such, typical psychobehavioral treatment for pain may involve substantial patient burdens in terms of time and costs, and the field may benefit from the development of treatments that are brief, scalable and broadly accessible.

The Veteran's Administration provides immediately available online tools that include the Breathe2Relax mobile application that is a stress management and diaphragmatic breathing tool (<http://t2health.dcoe.mil/mediakit/breath2relax-mobile-application>). Patients who are seeking to either reduce need for opioid medication or to simply bolster pain psychology skills may find “Less Pain, Fewer Pills” to be a helpful print resource [28]. Lastly, relaxation audiofiles or audio CDs are a low-cost resource for patients, and are particularly useful if used daily. Relaxation audio CDs or audio files are widely available and some are created specifically for pain management and people with medical concerns [29].

Pre-surgical Psychobehavioral Interventions

While the theoretical and clinical bases for pre-surgical psychological screening and intervention appear sound, the data from studies of pre-surgical mind-body therapies on post-operative outcomes have been mixed [30]. A recent systematic review of 20 prospective randomized controlled trials involving pre- and post-surgery study design (1297 patients) included studies on relaxation alone (N=8), guided imagery combined with relaxation (N=8), or hypnosis combined with relaxation (N=4). Across interventions there was partial to moderate support for positive impact on measures of psychological well-being. Specific to relaxation, there was a lack of evidence to support any salutary effects of relaxation therapy alone on post-surgical outcomes; however significant methodological problems cloud interpretation. For instance, in 6 studies (75%), patients were either given a relaxation audiotope or had a brief educational session on relaxation (10 minutes in one study, 40–70 minutes in another study) the day prior to surgery, which calls into question the likelihood that the intervention was ill-timed, perhaps providing insufficient time to practice

and gain the relaxation skills required to impact the post-surgical recovery. Additionally, studies tended to be non-directive (e.g., “listen to the CD as much as you want after surgery...”), used a variety of measures and outcomes; the lack of standardization yielded a smattering of positive results but overall insufficient evidence that either a relaxation audiofile/CD or brief relaxation delivered the day prior to surgery is beneficial.

Moderate evidence was found for guided imagery combined with relaxation and hypnosis combined with relaxation. However, the variability in methods was formidable. For instance, some studies included therapist contact whereas others did not; some provided clear direction for practice and others did not). Across interventions, factors that appeared to be associated with greater efficacy included therapist contact and/or an educational session and specific directions regarding frequency of practice. To date, no reports were found describing any pre-surgical interventions in hand surgery populations.

A notable omission from prior work is a combined relaxation and pain psychology approach, one that specifically targets pain-related anxiety and catastrophizing, provides pain education, and utilizes cognitive and behavioral strategies. Indeed, catastrophizing and pain-related anxiety are among the most mutable of all surgical risk factors (immutable factors include sex, age, trauma and injury location). For this reason, pain psychology prehabilitation is an attractive option to potentially reduce post-surgical pain and improve function. Patients can increase their confidence in their ability to modulate their experience of pain by learning skills that improve the self-regulation of cognition, emotion, and physiological hyperarousal. Functional MRI research has shown that use of such self-regulatory skills engages supraspinal structures and enhances descending noxious inhibitory pathways. Researchers of an fMRI study conducted on healthy volunteers reported that a brief mindfulness intervention (totaling 80 minutes) effectively reduced pain intensity and pain unpleasantness in the evoked pain paradigm [31], and that decreased pain was associated with reduced activation in regions of the brain associated with pain processing. Neuroimaging studies underscore the importance of cognition and attention in shaping individual differences in pain sensitivity [32].

Recently, a single-session, 2-hour pain psychology class developed to specifically treat pain catastrophizing showed promise in chronic pain outpatients. The brief intervention included specific psychoeducation regarding pain, catastrophizing, and self-regulation skills. Patients with chronic pain who underwent the brief pain catastrophizing group treatment (N=57) were found to have large treatment effects for reduced pain catastrophizing at 4 weeks post-treatment (Cohen’s $d = 1.15$) [33]. Current studies are examining the feasibility and preliminary efficacy of this brief catastrophizing treatment tailored to the perioperative setting.

What does this mean to the hand surgeon? Despite empirical associations, practical questions remain regarding the clinical application of pre-surgical psychological screening using the Pain Catastrophizing Scale and the Pain Anxiety Symptom Scale [34]. In all studies discussed here, pain catastrophizing and pain-related anxiety were examined as continuous variables, with no studies providing guidance for cut-scores. Clearly, more research is needed to appropriately guide the referral of patients to perioperative pain

psychology resources, particularly those who may exhibit few outward signs of pain-related anxiety or psychological distress to the surgeon or other care providers but may still be experiencing both and thus unwittingly causing a negative impact on their surgical outcomes.

Summary, Conclusions, and Future Directions

While acknowledging that associations across studies are not uniform, there appears to be moderate evidence suggesting that pre-surgical pain catastrophizing and pain-related anxiety predict short- and long-term outcomes for musculoskeletal surgery. Recent studies suggest that pre-surgical pain catastrophizing and pain-related anxiety predict recovery from hand surgery or trauma as indexed by pain and function. Results suggest that screening and treating pain-related distress may have a salutary effects in surgical populations, including reductions in pain, opioid use, and increased function.

Recommendations for future research include the need to report and adjust for analgesic use in the study design. The practical utility of study findings may be improved by researchers reporting means for variables (vs. correlations only), and by studies that risk-stratify patients and/or provide benchmarks to identify at-risk patients, thus informing referral to treatment. Finally, additional research is needed regarding the efficacy of brief pain psychology treatment in the perioperative setting. Interpretability of findings may be improved with greater standardization in design of perioperative pain psychology treatment studies, including the selection of measures and in the timing of the intervention relative to the surgical procedure. While the overall field is trending towards enhanced prehabilitation, pain psychology should be considered an integral component of multimodal care models. Pain psychology prehabilitation is a promising area of clinical research and care that stands to prepare the patient to self-optimize their surgical outcomes.

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Key Points

- Psychological factors—including pain-related psychological factors— have a significant influence on surgical outcomes.
- Pain catastrophizing—psychological responses to actual or anticipated pain— predict post-surgical pain intensity, opioid use, function, and the persistence of pain.
- A convergence of evidence suggests that treating pain catastrophizing and pain-related anxiety prior to surgery may improve recovery from surgery.
- Research on perioperative psychological interventions is relatively sparse and limited by methodological issues, including significant variation in the timing and content of the interventions.
- Recommendations for future research include pre-surgical delivery of interventions (psychological ‘prehabilitation’), and standardization of outcomes to include metrics of recovery and post-surgical medication use.

- A meta-analysis of 15 studies and 5046 musculoskeletal surgery patients revealed that pre-surgical pain catastrophizing was the strongest predictor of chronic post-surgical pain [15]
- Prolonged opioid use after musculoskeletal surgery—time to opioid cessation—is predicted by pre-surgical pain catastrophizing
- Pain psychology prehabilitation that focuses on skills acquisition may improve patients' ability to control their perioperative experience and possibly post-surgical outcomes.