Original Article

PAIN THRESHOLD AND PAIN TOLERANCE AS PREDICTORS OF ACUTE POSTOPERATIVE PAIN (Pain Threshold and Pain Tolerance)

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Summary

Introduction Acute postoperative pain can lead to various complications, affecting cardiovascular, respiratory, gastrointestinal, and renal systems, increases the costs of treatment and affects patient satisfaction. The pain prediction contributes to optimization of acute pain treatment with pain threshold and tolerance serving as key predictors of pain. Pain threshold measures the intensity of a stimulus causing pain, while pain tolerance is the maximum pain a person can endure. Objective/Aim This review aims to investigate whether pain threshold and pain tolerance can predict the intensity of acute postoperative pain. Methods We assessed published data on pain threshold, tolerance and acute postoperative pain from the past 10 years. Five relevant studies were included after screening 26 papers. Various study types were considered, including systematic reviews, prospective observational and randomized control studies. Results Patients with higher preoperative pain tolerance reported higher pain scores postoperatively. Another investigation found that patients with a higher threshold for pressure pain before surgery experienced less pain after surgery. Preoperative pain tolerance strongly predicts intensity of acute postoperative pain. Pain threshold derived from EEG has predictive accuracy for acute postoperative pain. Research on postoperative pain demonstrated that transcutaneous electrical nerve stimulation increased pain thresholds. A systematic review concluded that lower preoperative heat pain thresholds were associated with higher postoperative pain after various surgeries. Conclusion Pain threshold and pain tolerance could serve as good predictors of acute postoperative pain. While these tests show promise, challenges include time consumption and resource demands. Further research is needed to develop cost-effective and time-efficient tests for timely identification of patients at risk for acute postoperative pain.

Key words: acute postoperative pain; pain threshold; pain tolerance

Introduction

Inadequately managed acute postoperative pain may lead to complications affecting cardiovascular, respiratory, gastrointestinal, and renal systems, increase treatment costs, and negatively impact patient satisfaction, while also disrupting wound healing processes and elevating the risk of thromboembolic events (1). If we can predict acute pain, the treatment outcomes are likely to be better.

The perception of pain involves a complex and subjective experience where individuals interpret and make sense of unpleasant stimuli (1). This process includes sensory, emotional, and cognitive aspects, all contributing to how we perceive the quality of the pain we experience (2). Factors that significantly contribute to persons experiencing acute postoperative pain are pain threshold and tolerance. Pain threshold is measurement of the intensity of a physical stimulus that evokes pain, assessed by electrical or mechanical stimuli applied until the subject refers to a painful sensation. Pain tolerance is the maximum level of pain an individual can endure before they cannot longer tolerate painful stimuli (3).

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The aim of this review is to answer can pain threshold and pain tolerance predict the intensity of acute postoperative pain.

**Methods**

PubMed was searched for abstracts in English using the terms “pain threshold”, “pain tolerance” and “acute postoperative pain” published in last 10 years (date of literature search was 20th August 2023.) This resulted in the identification of 26 papers. After reviewing abstracts, 5 studies (Table 1) were fully read and included in this review. Other studies were omitted due to incorporation of research on chronic and persistent chronic pain, inflammatory pain, mood disorders and the absence of defined threshold. We included systematic reviews, prospective observational and randomized control studies.

**Results**

Cuff et al. examined subjective preoperative pain tolerance as a predictor of acute postoperative pain intensity on both postoperative days 1 and 7 following rotator cuff repair surgery. Patients exhibiting elevated subjective pain tolerance manifested higher acute pain scores, as assessed by the Visual Analog Scale (VAS) for pain rating (4).

Luedi et al. researched the correlation between preoperative pain pressure threshold and postoperative VAS scores in patients with anorectal carcinoma. The pressure pain threshold was assessed by an algometer, gently increasing pressure intensity until pressure was felt at VAS 3. They revealed that the preoperative pain pressure threshold was significantly associated with the intensity of postoperative pain (5).

**Table 1. Studies included in review**

<table>
<thead>
<tr>
<th>Study</th>
<th>Study type</th>
<th>Subjects</th>
<th>Number of subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative Sensory Testing to Predict Postoperative Pain</td>
<td>Systematic review</td>
<td>human</td>
<td>/</td>
</tr>
<tr>
<td>Preoperative Pressure Pain Threshold Is Associated With Postoperative Pain in Short-Stay Anorectal Surgery</td>
<td>Prospective Observational Study</td>
<td>human</td>
<td>128</td>
</tr>
<tr>
<td>Evaluation of Factors Affecting Acute Postoperative Pain Levels After Arthroscopic Rotator Cuff Repair</td>
<td>Prospective Observational Study</td>
<td>human</td>
<td>181</td>
</tr>
<tr>
<td>Transcutaneous Electric Nerve Stimulation Reduces Acute Postoperative Pain and Analgesic Use After Open Inguinal Hernia Surgery: A Randomized, Double-Blind, Placebo-Controlled Trial</td>
<td>Randomized Double-Blind Placebo-Controlled Study</td>
<td>human</td>
<td>80</td>
</tr>
<tr>
<td>Predictive value of EEG-derived pain threshold index for acute postoperative pain in children</td>
<td>Prospective Observational Clinical study</td>
<td>human</td>
<td>72</td>
</tr>
</tbody>
</table>

Analyzing changes in brain wave patterns through EEG during pain experiences allows for the determination of pain thresholds, presenting potential benefits in preschool children by alleviating the common adverse event of emergence agitation during the early recovery phase from general anesthesia. Research was conducted by Lv Jingjing et al. The utilization of the derived pain threshold index (PTI) from EEG exhibits superior predictive accuracy for postoperative acute pain in comparison to metrics such as surgical pleth index, heart rate, mean arterial pressure, and postoperative pain scores, including the Face, Legs, Activity, Cry, Consolability (FLACC) scale acquired five minutes after awakening, in preschool children undergoing laparoscopic hernia repair under general anesthesia. According to receiver-operating characteristic (ROC) curves, the best-fit cut-off values, encompassing combined sensitivity and specificity, were defined to distinguish mild pain from moderate-to-severe pain after surgery. The cut-off value of PTI was 58, with a sensitivity of 0.80 and a specificity of 0.71 (6).

Parseliunas et al. researched postoperative pressure pain in the inguinal region after hernia repair,
assessing pain threshold, maximal tolerable pressure threshold (MTPT), and interval of pressure pain tolerance (PTT). For the assessment of pressure pain threshold, the subjects were instructed to notify the researchers when pressure sensation becomes pain sensation. For the maximum tolerable pressure pain threshold, they reported when tolerable pain changed to suffering pain. Researchers calculated the interval of pressure pain tolerance (IPPT) by subtracting previous values. This value showed the interval at which subjects feel mild pain during pressure. If the value is zero, than pain is acute. Pain was assessed by an algometer in the inguinal region on the left and right side, and by VAS scale before and after transcutaneous electrical nerve stimulation (TENS). PPT and MTPT were similar in both groups before the procedure. After the TENS procedure, both were significantly increased on the surgical side. The IPPT value was similar before and after the procedure on both inguinal regions. Notably, a noteworthy reduction in pain scores, as indicated by the VAS, was observed following the intervention (7).

Sangesland et al. published a systematic review in which a group of authors suggested that a lower threshold for heat pain before surgery was associated with higher acute pain after surgery. Suprathreshold heat pain intensity was assessed in several studies and was positively associated with higher acute postsurgical pain after thoracic, gynecological, and orthopedic surgeries. In a study conducted before cholecystectomy, the assessment of cold pain tolerance revealed a negative association with acute pain intensity, suggesting that individuals with a lower pain tolerance to cold stimuli before surgery tended to experience higher levels of acute pain after the surgical procedure. The assessment of the electrical pain threshold demonstrates a significantly negative association with acute postoperative pain, indicating that a lower pain threshold on electrical stimulation before surgery was associated with higher pain after caesarean section and total knee replacement surgery. Pressure pain tolerance was evaluated in several studies, and the findings indicated that individuals with a lower pain tolerance to pressure before undergoing surgery tended to experience higher pain intensity after the surgical procedure (8).

Discussion

Patients exhibiting higher preoperative pain tolerance on the VAS scale emerge as the most robust predictive factor for heightened acute postoperative pain following rotator cuff repair. This observation underscores the imperative of tailoring interventions based on individual pain profiles.

The pressure pain threshold, investigated in select surgical studies, has proven applicable in patients undergoing short-stay anorectal surgery. Although limited by a small sample size and the inclusion of only one center, these studies reveal that the preoperative pressure pain threshold may not directly predict postoperative pain scores but does demonstrate an association between the two. This association holds potential utility in identifying patients requiring increased postoperative analgesia, facilitating the development of targeted pain management strategies. Significant disparities in analgesic requirements were observed among patients, attributable in part to variations in the administration of pudendal blocks.

In a pioneering study, the EEG-derived Pain Threshold Index (PTI) was applied for the first time to children as a model for acute postoperative pain. Findings by Lv Jingjing et al. assert that the derived PTI can predict acute postoperative pain in children aged 2–7 years with acceptable accuracy. Given the common occurrence of emergence agitation as a post-general anesthesia adverse effect in children, the timely recognition and management of postoperative pain could aid in preventing this phenomenon. Notably, the study indicates a strong correlation between PTI and the Surgical Pleth Index in children, predicting the incidence of acute postoperative pain.

A randomized, double-blind, controlled study conducted by Parseliunas evaluated the efficacy of TENS in treating postoperative pain. TENS, a safe and effective non-pharmacological intervention, demonstrated pain reduction, increased pain pressure threshold, and decreased analgesic consumption after inguinal hernia repair. While the study has limitations, including blinding issues and a limited male-only sample, the findings suggest that TENS could be incorporated into daily practice as part of a multimodal pain treatment approach.

Quantitative sensory testing (QST), which relies on pressure, vibration, thermal, and electrical impulses, is used in the diagnosis of nerve fiber dysfunction and the detection of neurological diseases or neuropathic pain. However, the lack of a standardized QST protocol for preoperative and
postoperative pain assessment limits its widespread use in clinical practice. Orthopedic surgeries demonstrate the best correlation with QST, while recent studies present conflicting data on the validity of thermal and electrical pain thresholds in predicting analgesic effects in surgical patients.

However, the routine use of these tests poses challenges due to time consumption and the demand for substantial resources. Despite these drawbacks, the potential benefits of early detection and treatment of pain-related problems emphasize the importance of further exploration and optimization of quantitative sensory testing in the perioperative context.

**Conclusion**

In this review, we concluded that pain threshold and pain tolerance can be good predictors of acute postoperative pain. Further research is needed to introduce cost-effective and time-saving tests for timely recognizing patients at risk of development of acute postoperative pain.

**References:**


