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Truncal blocks and teenager postoperative pain perception after laparoscopic surgical procedures

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Abstract

Introduction: The prevalence of moderate to severe pain is high in hospitalized teenage patients admitted to surgical services.

Objectives: The aims of this study were to determine (1) the preoperative and postoperative factors influencing teenager postoperative pain perception; and (2) suffering, defined as the patient's anxiety, pain catastrophizing thoughts, and mood.

Methods: Data were collected from medical records and from 2 medical interviews at the time of enrollment and postoperative day 1. Stepwise linear regression was conducted to assess variables that predicted teenagers' pain scores and suffering.

Results: Two hundred two patients (mean age = 13.8 years, SD = 1.9), 56.4% females, scheduled for laparoscopic surgical procedures completed the study. The variables found to be significant predictors of pain response in teenagers were pain on the day of surgery (6.81, 95% confidence interval [CI] = 0.08–13.55, P = 0.05) and use of regional anesthesia (single-injection rectus sheath, transversus abdominis plane, and paravertebral nerve blocks) (−6.58, 95% CI = −12.87 to −0.30, P = 0.04). The use of regional anesthesia was found to predict mood responses (all patients: 2.60, 95% CI = 0.68–4.52, P = 0.01; girls: 3.45, 95% CI = 0.96–5.93, P = 0.01; 14–17-year-old teens: 2.77, 95% CI = 0.44–5.10, P = 0.02) and to negatively predict catastrophic thoughts among all patients as a group (−4.35, 95% CI = −7.51 to −1.19, P = 0.01) and among 14- to 17-year-old teens (−5.17, 95% CI = −9.44 to −0.90, P = 0.02).

Conclusion: A comprehensive pain approach that includes truncal blocks may improve teenagers' postoperative pain control after laparoscopic surgeries.

Keywords: Truncal blocks, Postoperative pain, Teenager, Laparoscopic surgeries, Psychosocial factors

1. Introduction

Hospitalized teenage (11–18 years) patients admitted to surgical services reflect a higher incidence of moderate to severe pain than do infants (<1 year) and children (1–10 years) (38%, 32%, 17%, respectively).[8] One must certainly consider developmental maturation in children when assessing pain. Teenagers are more than merely "little" adults, and treating their postoperative pain can prove challenging because of significant interindividual differences.

The concept of pain embodies more than a sensation or a physical awareness of pain—it also includes the perception and the subjective interpretation of discomfort and suffering. Different factors can modify a teenager's perception of pain. Each patient has different previous experiences of pain, along with different expectations, temperaments and reactivity, emotions, and pain-coping strategies. Practitioners also use opioid pain medication and regional anesthesia to treat surgical trauma and additional painful sites. All of the aforementioned variables interact with the patient's mood, anxiety, and catastrophic attention to pain, thus influencing pain perception and analgesic consumption.

Postoperative pain remains undertreated in teenage patients,[7] and clinicians need to investigate this mosaic to better understand and treat their pain. Many variables can influence postoperative pain scores, eg, age, sex, anxiety, expected pain above 40 mm on a 100-mm Visual Analogue Scale (VAS), incision size, pain catastrophizing thoughts, preoperative pain, and surgical fear.[9,20] Unfortunately, most studies are limited to the adult population, investigating moderate/severe pain and specific procedures.[10,19,20] More studies are needed not only to avoid inappropriate extrapolation of adult data in teenage patients but also to research mild and moderate postoperative pain. Although not severe, the expected postoperative pain after laparoscopic surgeries—especially the day after surgery—unfortunately remains undertreated in the adult population.[6] We feel that many teenage patients are in pain on their first postoperative day, and

even mild pain should not go undertreated. Inadequate analgesia for initial procedures in children diminishes the effects of adequate analgesia in subsequent procedures.[22] This poorly understood topic will prove clinically useful in identifying potential factors that can influence teenager pain perception after laparoscopic surgeries. Identification of these factors may be helpful in treating teenager postoperative pain.

This study aims to determine (1) the preoperative and postoperative factors influencing teenager postoperative pain perception; and (2) suffering, defined as the patient's anxiety, pain catastrophizing thoughts, and mood.

2. Methods

2.1. Study design

We performed a secondary analysis of predictors on post-operative pain in teenage participants in the study "Clinical meaning of visual analogue scales (VAS) for teenage patients undergoing laparoscopic surgical procedures." This study was conducted at UPMC Children's Hospital of Pittsburgh (CHP) between December 2012 and August 2014 and was approved by the University of Pittsburgh Institutional Review Board. The study was registered at www.clinicaltrials.gov (NCT 017555065) on December 2012.

2.2. Participants

Participants were recruited from CHP and were selected based on a medical record review and a medical interview with the patient and parent on the day of surgery. Two thousand two hundred forty-one (2241) patients at CHP underwent laparoscopic procedures including robotic cholecystectomies between December 20, 2012, and August 13, 2014. Nine hundred fifty-nine patients were excluded because of the nature of their procedure (eg, orchiopexy, Nissen fundoplication, hernia repair, etc.); 623 patients were excluded for being outside of the target age range; 78 patients were excluded because the study team was unavailable to screen and consent patients; and 351 did not meet inclusion/exclusion criteria on a medical record review.

Of the 230 patients approached for the study, 6 did not meet inclusion/exclusion criteria, 3 patients or parents refused to participate, 2 did not fully complete consent (one started crying, and the other fell asleep for surgery), 6 patients were discharged before questionnaires were completed, 3 parents were unavailable on postoperative day 1, 2 parents withdrew consent on postoperative day 1, and 3 procedures were converted to open procedures. Three patient/parent/nurse units did not complete all study assessments. Two hundred two patients (along with their parents and nurses) completed all study procedures.

2.3. Inclusion and exclusion criteria

Patient inclusion criteria consisted of (1) age between 11 and 17 years, (2) scheduled for laparoscopic surgeries elective or emergent, and (3) overnight admission. Exclusion criteria included chronic pain conditions (pain more than 3 months), non–English-speaking family, history of cognitive impairment, developmental delay, and psychiatric medical history (except attention disorders such as attention-deficit disorder [ADD]/attention-deficit hyperactivity disorder [ADHD]). Patients were also excluded for positive pregnancy tests, taking drugs (including marijuana and other recreational drugs), and being medicated at home or in hospital with long-acting opioids

(methadone, OxyContin, oxymorphone ER, and morphine slow release) or clonidine, antipsychotic, antidepressant, and anxiolytic medications. Patients who experienced surgical, anesthesia, or medical complications, were discharged on the day of surgery, and had laparoscopic surgeries converted to open were also excluded. Those patients with no parent available to complete the questionnaires were also excluded.

2.4. Data collection

The principal investigator or one of the coinvestigators obtained informed consent on the day of surgery, before the surgery was performed. Patient demographic information was collected from medical records and from a medical interview at the time of enrollment and on postoperative day 1. The variables of interest were the patient's age (years), sex, weight (kg), height (cm), body mass index, race, prior surgical procedures (Y/N), medical history of ADD/ADHD, on medication or not for ADD/ADHD, pain history (on the day of surgery, before the surgery, Y/N, and in the past Y/N), pain medication taken at home, and on the day of surgery, opioids administered after surgery (Y/N), surgical procedure performed, the emergency of surgery (Y/N), number of painful sites (including nasogastric tube, orogastric tube, gastric tube, Foley catheter, intravenous lines, peripheral or central nerve block catheters, chest tube, and other catheters), and whether or not regional anesthesia was performed.

2.5. Surgical and anesthesia protocols

Surgical procedures were laparoscopies such as laparoscopic appendectomy (132), cholecystectomy (49) including robotic cholecystectomies (5), diagnostic laparoscopy (11), nephrectomy (1), oophorectomy (3), cystectomy, and cyst drainage (3), Heller myotomy (1), and laparoscopic Meckel resection (2). The type of anesthesia was not regulated by the study protocol. The choice of techniques and medication to be used were left to the discretion of the anesthesiologist and the acute pain service. The anesthetic performed was general anesthesia alone (97) or in combination with regional anesthesia single-injection techniques (105 patients) such as rectus sheath blocks (101 patients), transversus abdominis plane blocks (47 patients), paravertebral nerve blocks (2 patients), or a combination of rectus and transversus abdominis (45 patients). A total of 202 rectus sheath, 92 transversus abdominis plane, and 8 paravertebral nerve blocks were performed. Medications used for general anesthesia were propofol, midazolam, fentanyl, morphine, hydromorphone, ketamine, and rocuronium. The medication for regional anesthesia was ropivacaine 0.2% and 0.5%. Also, same local anesthetic was injected in surgical wound if the patient did not have a block. Postoperative pain was treated with morphine, hydromorphone, oxycodone, acetaminophen, and ibuprofen.

2.6. Study protocol

The research assistant visited all patients on day 1 after surgery and met the patient, the parent, and the nurse. The patient's pain scores were documented using the VAS, and anxiety was documented using the State-Trait Anxiety Inventory for Children (STAIC) questionnaires. Catastrophic thoughts were documented using the Pain Catastrophizing Scale for Children (PCSC), and the teenager's mood level was documented using the Brief Mood Introspection Scale (BMIS).

2.7. Questionnaires data

2.7.1. Visual Analogue Scale

The VAS is a horizontal 100-mm line. At the ends of this line, there are 2 labels: "no pain" and "the worst pain imaginable" (100 mm on the scale). Patients marked the line representing their level of pain.

2.7.2. Pain Catastrophizing Scale for Children

The PCSC is a 13-item questionnaire that is an adaptation of the PCS for use in adults. The scale was adapted by rewording one item, ie, simplifying the rating scale, and repeating the item stem at the beginning of each item ("When I am in pain…").[4] The children rate how frequently they experience each of the thoughts and feelings when they are in pain using a 5-point scale (0 = "not at all" and 4 = "extremely"). The PCSC consists of 3 subscales: (1) rumination (eg, "… I keep thinking about how much it hurts."); (2) magnification (eg, "… I wonder whether something serious might happen."); and (3) helplessness (eg, "… there is nothing I can do to reduce the pain."). There is evidence of construct and predictive validity.[4] The PCSC yields a total score that can range from 0 to 52, and 3 subscale scores for rumination, magnification, and helplessness. The scale evidenced excellent reliability with a Cronbach's alpha of 0.92; alphas for the subscales ranged from 0.68 to 0.88 in the current sample.[4]

2.7.3. State-Trait Anxiety Inventory for Children

Participants completed the state version of the STAIC to measure teenager anxiety on postoperative day 1.[21] This scale consists of 20 statements that ask the teenagers how they feel at that particular moment (eg, "I feel…"), by checking one of the 3 alternatives that describes the child best (eg, "very calm," "calm," or "not calm"). The total score for this scale ranges from 20 to 60. The alpha reliability of the STAIC scale was 0.90 in the current study.[21]

2.7.4. Brief Mood Introspection Scale

The BMIS is a mood adjective scale, with 16 adjectives, 2 selected from each of 8 mood states (happy, loving, calm, energetic, anxious, angry, tired, and sad).[15] Participants were asked to indicate how well each adjective described their present mood using a 4-point scale from 1 ("definitely do not feel") to 4 ("definitely feel"). Positive adjectives were added, whereas negatives adjectives were subtracted for a total score ranging from −24 to +24. The scale evidenced moderate reliability (Cronbach's alpha 0.83) for the current study.[15]

2.8. Statistical analyses

SAS software Version 9.3 of the SAS System for Windows. Copyright 2002-2010 SAS Institute, Inc, Cary, NC was used for analyses. After evaluating descriptive statistics (frequencies for categorical variables; means, SDs, and ranges of values for continuous measures) for the sample of 202 patients, we used stepwise linear regression to evaluate the patient's characteristics and perioperative factors predicting teenagers' VAS pain scores and factors predicting questionnaire scores (BMIS, STAIC, or PCSC).

In step 1 of stepwise linear regression modeling of factors predicting VAS scores, univariate models predicting the effect on the VAS of body mass index, white race (vs all other races), past surgeries, pain before surgery, pain on the day of surgery, pain medication use, diagnosis of ADD/ADHD, ADD/ADHD medication use, emergency case (vs scheduled case), use of regional anesthesia, and number of total tubes were evaluated. In step 2, any explanatory variables that demonstrated a P value less than or equal to 0.20 were included in multivariate models predicting the VAS. In step 3, any explanatory variables from step 2 that demonstrated a P value less than or equal to 0.05 were considered as significant predictors in the final models.

In step 1 of stepwise linear regression modeling predicting questionnaire responses, we evaluated univariate models predicting the effect on the BMIS, STAIC, or PCSC of regional anesthesia and necessity of opioids post-op but before questionnaire completion. In step 2, if both of the variables listed above demonstrated a P value less than or equal to 0.20, they were retained in multivariate models predicting the respective outcome (BMIS, STAIC, or PCSC), although we interpreted as significant a predictor with a P value less than or equal to 0.05.

Given developmental maturation in teenagers, we further evaluated models predicting the VAS, BMIS, STAIC, and PCSC separately among the 11- to 13-year-old subgroup (N = 88) and the 14- to 17-year-old subgroup (N = 114). We conducted the same analyses in male (N = 88) and female (N = 114) subgroups.

3. Results

3.1. Subjects

Two hundred two (202) patients (mean age = 13.8 years, SD = 1.9) were included in the final analysis. Participants were 56.4% females and self-identified as 89.6% White, 5.4% Black, and 5% other. Descriptive statistics are reported for all variables (**Table 1**).

Table 1

Patient and procedure characteristics.

	N = 202
Sex	Males, 88 (43.6%) Females, 114 (56.4%)
Race	White, 181 (89.6%) Black, 11 (5.4%) Other, 10 (5.0%)
Age (y)	13.8 ± 1.9 (11.0–17.0)
Weight (kg)	59.9 ± 17.2 (20.1–125.5)
Height (cm)	161.7 ± 10.3 (131.0–192.0)
BMI	22.9 ± 5.4 (12.2–43.4)
Diagnosis of ADD/ADHD	18 (8.9%)
Use of ADD/ADHD medication	7 (3.5%)
Emergency case	90 (44.6%)
Procedure	Appendectomy, 132 (65.3%) Cholecystectomy, 49 (24.3%) Other, 21 (10.4%)
Regional anesthesia	105 (52.0%)
Had previous surgery under anesthesia	94 (46.5%)
Pain before surgery	185 (91.6%)
Pain on the day of surgery	140 (69.3%)
Pain medication use before surgery	118 (58.4%)
Opioid administered after surgery	169 (83.7%)
No. of total lines/tubes/catheters	1.1 ± 0.6 (0–4)

Continuous measures are presented as mean ± SD and range of values.
ADD, attention-deficit disorder; ADHD, attention-deficit hyperactivity disorder; BMI, body mass index.

The distribution of anesthesia type did not differ significantly within each age group ($P = 0.83$). With respect to gender, however, males were more likely to receive combined general and regional anesthesia (55/88; 62.5%), whereas females were more likely to receive general anesthesia alone (64/114; 56.1%) ($P = 0.01$). Outcome measures are presented in **Table 2**.

3.2. Perioperative variables influencing teenager postoperative pain perception

3.2.1. All patients as a group

The preoperative and postoperative factors influencing teenager postoperative pain perception are presented in **Table 3**. The variables found to be significant predictors of pain response in teenagers were pain on the day of surgery (6.81, 95% confidence interval [CI] = 0.08–13.55, $P = 0.05$) and use of regional anesthesia (−6.58, 95% CI = −12.87 to −0.30, $P = 0.04$).

3.2.2. Subgroup analysis

In subgroup analyses, only pain on the day of surgery (13.04, 95% CI = 2.22–23.86, $P = 0.02$) was a pain predictor for boys. Pain on the day of surgery (12.43, 95% CI = 2.91–21.94, $P = 0.01$) and pain medication use before surgery (−12.85, 95% CI = −21.71 to −3.99, $P = 0.005$) were pain predictors among teenagers aged 14 to 17 years. No variables predicted VAS responses in subgroup analyses of girls or of 11- to 13-year-old teenagers (**Table 3**).

3.3. Perioperative variables influencing teenager psychosocial factors

The preoperative and postoperative factors influencing teenager postoperative anxiety, pain catastrophizing thoughts, and mood are presented based on age (**Table 4**) and sex subgroups (**Table 5**).

3.3.1. All patients as a group and subgroup analysis

Postoperative opioid use (before questionnaire completion) did not significantly predict teenagers' responses on the anxiety, catastrophic thoughts, or mood (−3.68, $P = 0.07$) assessments in the sample as a whole or in any of the subgroup analyses (boys, girls, 11–13-year-old teens, or 14–17-year-old teens).

The use of regional anesthesia was found to predict mood responses on the BMIS (all patients: 2.60, 95% CI = 0.68–4.52, $P = 0.01$; girls: 3.45, 95% CI = 0.96–5.94, $P = 0.01$; and 14–17-year-old teens: 2.77, 95% CI = 0.44–5.10, $P = 0.02$), but not among boys or among 11- to 13-year-old teens (**Tables 4 and 5**). Regional anesthesia use was also found to negatively predict catastrophic thoughts on the PCSC among all patients as a group

(−4.35, 95% CI = −7.51 to −1.19, $P = 0.01$) and among 14- to 17-year-old teens (−5.17, 95% CI = −9.44 to −0.90, $P = 0.02$), but not among sex-specific subgroups or among younger teens (**Tables 4 and 5**).

In **Figure 1**, we present summary of results for all patients as a group.

4. Discussion

Pain is a complex, dynamic, and multidimensional perception, and its understanding requires a comprehensive approach that starts with preoperative risk assessment, assessment of nociceptive stimulus, information about pain control modalities, and recognition of psychological factors. Postoperative pain consists of nociception, perception of pain, and suffering.[13] Surgical trauma and painful sites such as Foley catheters, nasogastric tubes, and intravenous lines represent the nociceptive component. The patient's perception of pain and suffering determines their self-reported pain score. Pain has a cognitive and affective component, so situational and emotional factors that exist when patients experience pain can profoundly alter the strength of these perceptions.

A "pain" diagnostic is often difficult to resolve in a teenager population. We hypothesized that preoperative and postoperative variables influence pain perception and psychological assessments. Children's memories for pain play a powerful role in pain experiences,[16] and we examined whether previous surgical experience influenced postoperative pain perception. In our patient population, we found that predictors of pain after laparoscopic surgery consisted of pain on the day of surgery and pain medication use before surgery. This finding is supported by a study of 1490 adult patients undergoing the heterogeneous surgical procedure where pain before surgery predicted moderate to severe pain afterwards.[20] In addition, pain intensity on the day of surgery predicts chronic postsurgical pediatric pain.[18] These findings suggest that pain before surgery should be treated better.

Wolff et al. found a reduced pain perception in children and adolescents with ADHD who do not medicate with methylphenidate.[23] We investigated whether a history of ADHD/ADD predicts postoperative pain in teenage patients, and we found weak evidence for a difference ($P = 0.08$) in this subgroup. Teenage patients with a history of ADHD/ADD who do not undergo treatment with medication had fewer pain perceptions. This contradicts our clinical impression that this group has an increased pain sensitivity and a decreased threshold to pain. Perhaps, this is a result of the patients' abilities to distract themselves while coping with pain.

The perioperative period may be a vulnerable period for the development of persistent opioid use, and the use of regional anesthesia as part of multimodal analgesia may decrease opioid use after surgery. We conducted a stepwise linear regression to

Table 2

Outcome measures.

Teenage patient responses	N = 202	No regional anesthesia (N = 97)	Regional anesthesia (N = 105)	P
VAS	37.0 ± 22.3 (0.0 to 91.0)	40.9 ± 22.5 (1.5 to 90.0)	33.3 ± 21.7 (0.0 to 91.0)	**0.02**
BMIS	4.6 ± 7.1 (−18.0 to 21.0)	3.3 ± 6.6 (−17.0 to 18.0)	5.9 ± 7.3 (−18.0 to 21.0)	**0.01**
STAIC	32.5 ± 5.9 (21.0 to 51.0)	33.3 ± 5.6 (21.0 to 51.0)	31.8 ± 6.1 (21.0 to 51.0)	0.08
PCSC	22.9 ± 11.6 (1.0 to 50.0)	25.1 ± 11.4 (1.0 to 50.0)	20.8 ± 11.5 (1.0 to 46.0)	**0.01**

Regional anesthesia group means on outcomes are compared with T tests. Continuous measures are presented as mean ± SD and range of values. Significant *P* values are bolded.
BMIS, Brief Mood Introspection Scale; PCSC, Pain Catastrophizing Scale for Children; STAIC, State-Trait Anxiety Inventory for Children; VAS, Visual Analogue Scale.

Table 3

Perioperative predictors on VAS pain scores.

Variable	All patients (N = 202)			14–17-year-old teens (N = 114)			Boys (N = 88)		
	Parameter estimate	95% confidence interval	P	Parameter estimate	95% confidence interval	P	Parameter estimate	95% confidence interval	P
Pain on the day of surgery	6.81	0.08 to 13.55	**0.05**	12.43	2.91 to 21.94	**0.01**	13.04	2.22 to 23.86	**0.02**
Regional anesthesia	−6.58	−12.87 to −0.30	**0.04**	N/A	N/A	N/A	N/A	N/A	N/A
BMI	0.20	−0.06 to 0.47	0.14	0.20	−0.08 to 0.47	0.16	0.25	−0.04 to 0.54	0.10
Pain before surgery	N/A	N/A	N/A	13.19	−2.71 to 29.09	0.11	N/A	N/A	N/A
Pain medication before surgery	N/A	N/A	N/A	−12.85	−21.71 to −3.99	**0.01**	N/A	N/A	N/A
ADD/ADHD	N/A	N/A	N/A	−15.84	−33.53 to 1.85	0.08	N/A	N/A	N/A

No variables were found to be significant predictors of VAS pain scores among 11- to 13-year-old teens and girls. Attention-deficit disorder/attention-deficit hyperactivity disorder medication was not a significant predictor of VAS response in any of the models (all patients, girls, boys, younger teens, or older teens). Significant P values are bolded.
ADD, attention-deficit disorder; ADHD, attention-deficit hyperactivity disorder; BMI, body mass index; VAS, Visual Analogue Scale.

assess the effects of regional anesthesia and of postoperative opioid use on anxiety, catastrophic thoughts, and mood. Postoperative opioid use (before questionnaire completion) did not significantly predict the teenagers' responses on anxiety, catastrophic thoughts, or mood assessments in the sample as a whole or in any of the subgroup analyses. However, we found weak evidence for a difference ($P = 0.07$) for teenage boys; opioid consumption negatively influenced their mood. This came as a surprise because we expected that teenagers who received opioids would have their pain controlled and their mood favorable. Opioids can have induced hyperalgesia or abnormal pain sensitivity—it is easier to demonstrate this in animals,[3] but difficult in humans,[5,12] and continued research is necessary to identify whether opioid exposure influences pain perception and mood after surgery.

Sommer et al.[20] found that anesthetic technique played a role in predicting pain in adults. Risk of pain >40 mm immediately after surgery and on day 2 afterwards is significantly higher in patients receiving general anesthesia only. Regional anesthesia techniques were neuroaxial including continuous epidural infusions and extremity peripheral blocks. Our study differs from this in many ways. We investigated truncal blocks in combination with general anesthesia, and we examined teenager pain perception on day 1 after surgery when there is no residual analgesia from nerve blocks.

It is interesting that regional anesthesia was found to predict not only teen VAS pain scores but also their mood and catastrophizing attention to pain responses. In experimentally induced pain, internalizing/catastrophizing and seeking emotional support may be considered as a pain-prone coping strategy—positive self-statements and behavioral distraction may be considered as a pain-resistant coping strategy.[14]

The catastrophic attention to pain/mood interaction arises as a *chicken or the egg* dilemma. Pain drives psychological distress, so if the pain goes away, then patients feel better and have other areas to think. If the pain does not go away, then they think more about their pain, get more upset, are not satisfied, and suffer. Truncal blocks seem to be an independent factor that can influence pain and psychological distress, and consequently can influence treatment interventions and satisfaction with pain control.

There are several explanations for this observation. First, regional analgesia can act as a protective analgesic. Pain pathways consist of transduction, transmission, perception, and modulation, and regional anesthesia influences transduction (blocks nerve impulses and decreasing nociception) and transmission (blocks pain signal transmission from the peripheral system to the dorsal horn, and then along the sensory tract to the brain). Peripheral sensitization of nociceptors after incision seems to be important for pain hyperalgesia,[17] and more studies need to be conducted to investigate whether regional anesthesia blocks decrease pain hyperalgesia, lower spinal sensitization, and influence pain perception after local anesthetic wears off.

Second, regional anesthesia could potentially modulate psychosocial factors and influence pain perception. Functional magnetic resonance imaging studies in rodents showed that

Table 4

Perioperative predictors on psychological factor scores based on age.

Variable	All patients (N = 202)			11–13-year-old teens (N = 88)			14–17-year-old teens (N = 114)		
	Parameter estimate	95% confidence interval	P	Parameter estimate	95% confidence interval	P	Parameter estimate	95% confidence interval	P
BMIS response Regional anesthesia	2.60	0.68 to 4.52	**0.01**	2.40	−0.83 to 5.63	0.15	2.77	0.44 to 5.10	**0.02**
STAIC response Regional anesthesia	−1.45	−3.08 to 0.18	**0.08**		N/A		−1.74	−3.64 to 0.16	0.08
PCSC response Regional anesthesia	−4.35	−7.51 to −1.19	**0.01**	−3.28	−7.98 to 1.42	0.18	−5.17	−9.44 to −0.90	**0.02**

Neither regional anesthesia nor necessity of opioids post-op but before questionnaire completion was found to be significant predictors of STAIC response among 11- to 13-year-old teens. Significant P values are bolded.
BMIS, Brief Mood Introspection Scale; PCSC, Pain Catastrophizing Scale for Children; STAIC, State-Trait Anxiety Inventory for Children.

Table 5

Perioperative predictors on psychological factor scores based on gender.

Variable	Girls (N = 114)			Boys (N = 88)		
	Parameter	95% confidence interval	P	Parameter	95% confidence interval	P
BMIS response						
Regional anesthesia	3.45	0.96 to 5.94	**0.01**	−3.68	−7.6 to 0.24	0.07
STAIC response						
Regional anesthesia	−1.39	−3.45 to 0.67	0.19		N/A	
PCSC response						
Regional analgesia	−4.02	−8.16 to 0.12	0.06	−3.24	−8.24 to 1.76	0.21

Neither regional anesthesia nor necessity of opioids post-op but before questionnaire completion was found to be significant predictors of STAIC response among boys. Significant P values are bolded.
BMIS, Brief Mood Introspection Scale; PCSC, Pain Catastrophizing Scale for Children; STAIC, State-Trait Anxiety Inventory for Children.

brain regions activated during incision belong to distinctive pathways, including the affective/attentional pathway coding for the unpleasantness of pain. This pathway may play a role into the affective component of incisional pain, and more studies should be conducted to investigate this.[1]

Finally, we used age and gender subgroups to validate our results. The patient age influences pain perception but not pain intensity in a sample of 351 teenage patients (mean age 15.3 years, range 12–18) who underwent various surgical procedures.[7] In a study of 244 healthy children and teenagers with experimental pain (mean age 12.73, ±2.98 years), older participants were more likely to use more solving and externalizing coping strategies than younger participants.[14] In our study, we found predictors that influence pain perception only in a group of 14 to 17 year olds; this may allow them better to cope with pain. This can be explained by the specific modulatory effect of hormones at puberty that maybe reaches a peak level later in puberty.

There is a sex difference in experiences of pain[2]; teenage females experienced more severe postoperative pain[7] and chronic pain.[11] Pain-coping strategies differ in adolescents with chronic pain; females used more social support, positive strategy, and internalizing/catastrophizing, whereas males reported engaging in more behavioral distractions.[11] Sex differences were found in our studies: no variables predicted VAS responses in subgroup analyses of girls, but regional anesthesia influenced their mood and this way influences the emotional/psychological component of pain perception. We do not know any underlying mechanism that can contribute to this difference, but teenage girls can have a different unpleasantness of pain than teenage boys. Even if various coping strategies have been found to differ between men and women, we did not find any difference in the influence of regional anesthesia on catastrophizing attention to pain.

There are some limitations to this study. First, we did not investigate all potential predictors of postoperative pain, but this lay beyond the scope of this article, requiring further research. We did not have baseline psychosocial factor measurements (such as trait anxiety), and we do not know the differences between subgroups. We decided not to measure them on the day of surgery when they could be enhanced by perioperative pain and altered by residual sedation. Second, other environmental and genetical factors occurring during our assessment may cause children to feel more or less pain. Third, it was not practical to standardize the anesthetic techniques; however, when the assessments were complete, there was no residual regional analgesia. Postoperatively, none of the patients received ketamine, gabapentin, antidepressants, selective serotonin reuptake inhibitors, serotonin-norepinephrine reuptake inhibitors, lidocaine patches, or any medication that could influence pain control and perception. A further weakness is our population was predominantly white, and this cross-cultural validity should be investigated. Finally, our results are applicable to teenager presenting with acute pain after a laparoscopic surgery and may not be appropriate to generalize to other surgical procedures.
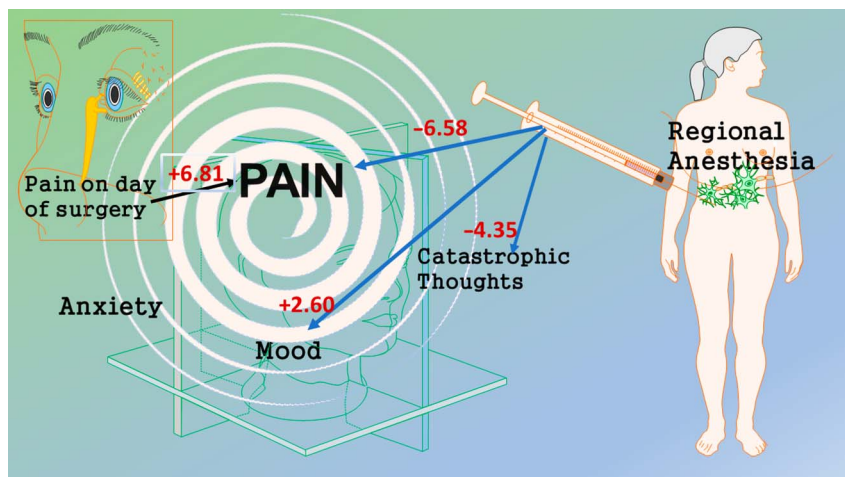

Figure 1. Perioperative variables influencing teenager postoperative pain perception, mood, and catastrophic thoughts: Parameter estimates were reported. The figure composed using Motifolio Inc. diagrams. A comprehensive pain approach including truncal block may improve postoperative pain control and psychosocial factors (mood and catastrophizing thoughts about pain) of teenagers undergoing laparoscopic surgeries.

In conclusion, the current findings suggest that in teenagers undergoing laparoscopic surgeries, truncal blocks can effectively reduce physical pain and influence psychological/emotional pain and may lead to better postoperative pain control. More studies are needed to investigate other preoperative variables that can influence teenager postoperative pain perception, and to provide more insights into regional anesthesia mechanisms that reduce incisional pain and act as a pain-protective strategy to improve psychosocial factors after surgery.

Disclosures

Acknowledgements

References

[1] Amirmohseni S, Segelcke D, Reichl S, Wachsmuth L, Gorlich D, Faber C, Pogatzki-Zahn E. Characterization of incisional and inflammatory pain in rats using functional tools of MRI. Neuroimage 2016;127:110–22.

[2] Bartley EJ, Fillingim RB. Sex differences in pain: a brief review of clinical and experimental findings. Br J Anaesth 2013;111:52–8.

[3] Celerier E, Rivat C, Jun Y, Laulin JP, Larcher A, Reynier P, Simonnet G. Long-lasting hyperalgesia induced by fentanyl in rats: preventive effect of ketamine. Anesthesiology 2000;92:465–72.

[4] Crombez G, Bijttebier P, Eccleston C, Mascagni T, Mertens G, Goubert L, Verstraeten K. The child version of the pain catastrophizing scale (PCS-C): a preliminary validation. PAIN 2003;104:639–46.

[5] Fishbain DA, Cole B, Lewis JE, Gao J, Rosomoff RS. Do opioids induce hyperalgesia in humans? An evidence-based structured review. Pain Med 2009;10:829–39.

[6] Gerbershagen HJ, Aduckathil S, van Wijck AJ, Peelen LM, Kalkman CJ, Meissner W. Pain intensity on the first day after surgery: a prospective cohort study comparing 179 surgical procedures. Anesthesiology 2013; 118:934–44.

[7] Gillies ML, Smith LN, Parry-Jones WL. Postoperative pain assessment and management in adolescents. PAIN 1999;79:207–15.

[8] Groenewald CB, Rabbitts JA, Schroeder DR, Harrison TE. Prevalence of moderate-severe pain in hospitalized children. Paediatr Anaesth 2012; 22:661–8.

[9] Ip HY, Abrishami A, Peng PW, Wong J, Chung F. Predictors of postoperative pain and analgesic consumption: a qualitative systematic review. Anesthesiology 2009;111:657–77.

[10] Kalkman CJ, Visser K, Moen J, Bonsel GJ, Grobbee DE, Moons KG. Preoperative prediction of severe postoperative pain. PAIN 2003;105: 415–23.

[11] Keogh E, Eccleston C. Sex differences in adolescent chronic pain and pain-related coping. PAIN 2006;123:275–84.

[12] Lee M, Silverman SM, Hansen H, Patel VB, Manchikanti L. A comprehensive review of opioid-induced hyperalgesia. Pain Physician 2011;14:145–61.

[13] Loeser JD, Melzack R. Pain: an overview. Lancet 1999;353:1607–9.

[14] Lu Q, Tsao JC, Myers CD, Kim SC, Zeltzer LK. Coping predictors of children's laboratory-induced pain tolerance, intensity, and unpleasantness. J Pain 2007;8:708–17.

[15] Mayer JD, Gaschke YN. The experience and meta-experience of mood. J Personal Soc Psychol 1988;55:102–11.

[16] Noel M, Rabbitts JA, Tai GG, Palermo TM. Remembering pain after surgery: a longitudinal examination of the role of pain catastrophizing in children's and parents' recall. PAIN 2015;156:800–8.

[17] Pogatzki EM, Vandermeulen EP, Brennan TJ. Effect of plantar local anesthetic injection on dorsal horn neuron activity and pain behaviors caused by incision. PAIN 2002;97:151–61.

[18] Rabbitts JA, Fisher E, Rosenbloom BN, Palermo TM. Prevalence and predictors of chronic postsurgical pain in children: a systematic review and meta-analysis. J Pain 2017;18:605–14.

[19] Rosseland LA, Stubhaug A. Gender is a confounding factor in pain trials: women report more pain than men after arthroscopic surgery. PAIN 2004; 112:248–53.

[20] Sommer M, de Rijke JM, van Kleef M, Kessels AG, Peters ML, Geurts JW, Patijn J, Gramke HF, Marcus MA. Predictors of acute postoperative pain after elective surgery. Clin J Pain 2010;26:87–94.

[21] Spielberger CD, Edwards CD. State-Trait Anxiety Inventory for Children: STAIC: how I feel questionnaire: professional manual. Redwood City: Mind Garden, 1973.

[22] Valeri BO, Ranger M, Chau CM, Cepeda IL, Synnes A, Linhares MB, Grunau RE. Neonatal invasive procedures predict pain intensity at school age in children born very preterm. Clin J Pain 2016;32:1086–93.

[23] Wolff N, Rubia K, Knopf H, Holling H, Martini J, Ehrlich S, Roessner V. Reduced pain perception in children and adolescents with ADHD is normalized by methylphenidate. Child Adolesc Psychiatry Ment Health 2016;10:24.