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Slow Deep Breathing for Acute Post-Appendectomy Pain: A Gate Control Theory-Based Nursing Care Study

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ABSTRACT

Introduction: Acute pain is one of the most common complications following appendectomy and may delay mobilization, impair rest, and prolong postoperative recovery if inadequately managed. Slow deep breathing (SDB) is recommended as an independent non-pharmacological nursing intervention in the Indonesian Nursing Intervention Standards; however, evidence describing its implementation and clinical outcomes in routine postoperative nursing care remains limited. This study evaluated the effectiveness of SDB therapy on acute pain among a post-appendectomy patient within the nursing care process.

Methods: A quasi-experimental study using a one-group pretest–posttest case design was conducted at Bangil Regional General Hospital (RSUD Bangil), Indonesia. One post-appendectomy patient experiencing acute pain received SDB therapy once daily for three consecutive days in addition to standard postoperative care. Each session consisted of inhalation through the nose for four seconds, breath-holding for two seconds, and exhalation through pursed lips for eight seconds, repeated for three cycles. Pain intensity was assessed before and after each session using the Numeric Rating Scale (NRS), while physiological responses, including pulse rate and pain-related behaviors, were observed throughout the intervention.

Results: The patient's baseline pain score was 7 (severe pain), which progressively decreased to 3 (mild pain) after the third intervention session. Pulse rate declined from 104 to 87 beats per minute, accompanied by the disappearance of grimacing, restlessness, and protective behaviors, indicating improved comfort and physiological stabilization.

Conclusion: Slow deep breathing effectively reduced postoperative pain intensity and improved physiological responses following appendectomy. As a safe, inexpensive, and nurse-led intervention, SDB can be incorporated into routine postoperative pain management alongside pharmacological therapy to enhance recovery, although larger clinical studies are required to confirm these findings.

KEYWORDS

Acute Pain; Appendectomy; Breathing Exercises; Nursing Care; Pain Measurement.

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INTRODUCTION

A patient waking from appendectomy rarely measures recovery in laboratory values first; the first and most insistent signal is pain radiating from the surgical site with every cough, turn, or attempt to sit up (Ramadhani & M, 2024). Appendicitis remains one of the most frequent indications for emergency abdominal surgery worldwide, and the pain that follows appendectomy is neither incidental nor easily dismissed: it is a predictable consequence of tissue trauma that, left unaddressed, can undermine the very recovery the surgery was meant to restore. Indonesia's Ministry of Health recorded approximately 621,435 appendicitis cases in 2021, underscoring that this is not a rare surgical event but a recurring burden on nursing wards across the country (Joseph et al., 2022; Surjadi, 2023). Roughly three-quarters of patients undergoing abdominal surgical procedures, including appendectomy, report clinically significant post-operative pain that can impair physiological function and delay recovery (Rokhmah et al., 2026). Preliminary medical record data from Bangil Regional General Hospital (RSUD Bangil) in 2025 similarly pointed to a substantial number of post-appendectomy patients presenting with acute pain in the surgical wound area, each requiring individualized nursing intervention rather than a one-size-fits-all protocol.

The pain that follows appendectomy has a clear physiological basis. Surgical incision and tissue injury to the abdominal wall and peritoneum trigger the release of inflammatory mediators, including prostaglandins, histamine, and bradykinin, which sensitize nociceptors and relay pain impulses toward the central nervous system (Jarrah et al., 2022; Marsaid et al., 2024). Patients typically describe the resulting sensation as sharp, cutting, or stinging in the right lower quadrant, intensifying with movement, coughing, or a change in position. The Indonesian Nursing Diagnosis Standards (SDKI) capture this clinical picture through a cluster of major indicators, including verbal complaints of pain, grimacing, protective behavior, restlessness, and an elevated heart rate (Putri et al., 2025). These signs are not merely diagnostic labels; each reflects a physiological stress response that, if sustained, can impair early mobilization and raise the risk of further post-operative complications, ranging from respiratory compromise to prolonged psychological distress.

Among the independent nursing interventions recommended by the Indonesian Nursing Intervention Standards (SIKI) for non-pharmacological pain management is slow deep breathing (SDB) therapy (Agustin et al., 2022; Pratiwi & Maryoto, 2025; Silpiyani & Novitasari, 2023). SDB lengthens both the inspiratory and expiratory phases of the breathing cycle, slowing respiratory rate and encouraging physical and psychological relaxation. The mechanism is not merely behavioral: prolonged, controlled exhalation stimulates vagal afferents, shifting autonomic balance toward parasympathetic dominance, which in turn lowers heart rate and blood pressure and promotes endorphin release that dampens pain transmission (Rasmini et al., 2025). This physiological pathway is consistent with evidence from postoperative populations, where SDB has been associated with measurable reductions in pain scale scores alongside improvement in physiological indicators following the intervention.

Even so, most of the evidence supporting SDB in postoperative care describes group-level outcomes rather than the granular, day-to-day clinical trajectory a bedside nurse actually observes: how a patient learns the technique, where they struggle, and how their pain and vital signs shift from one session to the next (Kusyani et al., 2024; Mahmudi & Dinaryanti, 2022). Case-level accounts of comprehensive nursing care built around SDB, particularly for post-appendectomy patients, remain limited, and few reports connect the observed pattern of pain reduction back to an explicit theoretical account of how breathing-based relaxation modulates nociception (Malinda et al., 2025). This gap matters because nurses implementing SDB at the bedside need more than a summary effect size; they need a reproducible sequence of activities and a defensible explanation

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of the mechanism they are relying on. Accordingly, this study aimed to describe the nursing care provided to a post-appendectomy patient with acute pain and to evaluate the change in pain intensity and associated physiological indicators before and after three days of SDB therapy at RSUD Bangil, framed against Melzack and Wall's Gate Control Theory of pain as an explanatory lens. What this report adds is a structured, pre-test/post-test description of a single nursing case, reported in a manner consistent with recognized single-case reporting conventions, that pairs quantitative NRS and vital-sign trends with the day-to-day implementation detail typically absent from published case reports (Prayogi et al., 2022). The remainder of this paper presents the study design and intervention protocol, followed by a combined results-and-discussion section that interprets the observed pattern of change against nursing pain theory, and closes with a conclusion summarizing the clinical implications (Kk et al., 2025).

MATERIALS AND METHODS

Research Design

This study used a quasi-experimental, one-group pre-test post-test design applied to a single clinical case and embedded within the nursing process, comprising assessment, nursing diagnosis, planning, implementation, and evaluation. A single-subject, repeated-measures design was chosen deliberately rather than by default: it allowed pain intensity and physiological indicators to be tracked before and after each of three consecutive intervention sessions, producing a within-subject comparison that a one-off, cross-sectional case description cannot provide, while remaining feasible within a short clinical placement and a single-ward setting. This case was reported in accordance with the Single-Case Reporting guideline In Behavioural interventions (SCRIBE) 2016 statement, an EQUATOR Network-endorsed guideline for single-case and single-subject intervention research, adapted here for a nursing case study. In line with SCRIBE, the report specifies baseline characterization, a fully detailed intervention protocol, repeated pre- and post-session outcome measurement, and explicit description of concurrent (pharmacological) co-interventions administered alongside SDB therapy.

Setting and Participant

The study was conducted in the Anggrek Ward of Bangil Regional General Hospital (RSUD Bangil), Pasuruan Regency, Indonesia, from April 20 to 22, 2026. The participant was a single adult patient with a medical diagnosis of post-appendectomy, selected purposively against pre-specified inclusion and exclusion criteria. Inclusion criteria were: a diagnosis of post-appendectomy with acute pain on the first post-operative day; presentation of at least 80% of the major signs and symptoms of acute pain (pain complaint, grimacing, protective behavior, restlessness, and increased pulse rate); full consciousness (compos mentis) with intact communication ability; and voluntary participation evidenced by signed informed consent. Exclusion criteria were severe respiratory disorders, decreased consciousness, or cognitive and psychotic impairment that would prevent the patient from following SDB instructions.

Instruments

Three instruments supported data collection: a structured nursing assessment form covering biological, psychological, social, and spiritual domains; a clinical observation sheet for vital signs and behavioral responses to the intervention; and the Numeric Rating Scale (NRS), an 11-point scale ranging from 0 (no pain) to 10 (worst imaginable pain), administered immediately before and immediately after each SDB session to capture within-session change in pain intensity.

Intervention Protocol: Sequence of Activities

The SDB protocol followed a fixed, reproducible sequence at every session, delivered once daily for three consecutive days (April 20–22, 2026), with each session structured as follows: (1) pre-session assessment, recording NRS pain score, pulse rate, and observable behavioral indicators (grimacing, restlessness, protective behavior); (2) positioning the patient in a semi-Fowler position to optimize diaphragmatic excursion and comfort; (3) brief re-orientation to the technique's purpose and a short demonstration by the nurse; (4) guided breathing practice, in which the patient inhaled slowly through the nose for four seconds, held the breath for two seconds, and exhaled slowly through pursed lips for eight seconds, with this cycle repeated three times under direct nurse supervision; (5) a period of independent practice, encouraged whenever the patient perceived pain between sessions; and (6) post-session assessment, re-recording NRS score, pulse rate, and behavioral indicators, followed by documentation. On day 1, the patient required repeated verbal cueing and physical guidance to master the breathing rhythm, as pain interfered with concentration; by day 2, she performed the sequence with minimal prompting; by day 3, she executed the technique independently and reported applying it spontaneously between formal sessions. Collaborative, physician-directed pharmacological management, comprising scheduled analgesics and antibiotics, continued in parallel throughout the three-day period and is reported here as a concurrent co-intervention rather than omitted from the record.

Data Collection Procedure

Data were gathered through interviews, physical examination, and documentation review. Interviews elicited subjective information on the history of appendectomy, the chief complaint, the characteristics of the pain experienced, and any prior pain-management efforts. Physical examination combined inspection, palpation, percussion, and auscultation to assess clinical status and to observe the patient's response throughout the nursing care process. Documentation review, including laboratory results and the medical record, supplemented the clinical picture and supported cross-verification of the reported diagnosis and treatment plan.

Data Analysis

Interview, observation, and documentation data were compiled and evaluated systematically, then presented as structured narratives, a comparative pre-test/post-test table, and supporting figures. Pre- and post-session NRS scores, pulse rate, and behavioral indicators were compared descriptively across the three intervention days to characterize the within-subject trend. These findings were then interpreted against relevant nursing pain theory and prior empirical literature to support inductive conclusions spanning assessment, diagnosis, intervention, implementation, and evaluation.

Ethical Considerations

This study received ethical approval from the Health Research Ethics Committee of the Faculty of Nursing, University of Jember. Ethical principles were upheld throughout, including informed consent (voluntary participation, free of coercion), anonymity (use of initials rather than full names), beneficence (ensuring the intervention was both safe and beneficial), and confidentiality (protection of all patient data).

RESULTS AND DISCUSSION

Ny. U, a 32-year-old post-appendectomy patient, was assessed on April 20, 2026, using a head-to-toe approach on the first post-operative day. Subjectively, she reported acute pain in the right lower quadrant of the abdomen, described as a cutting and stinging sensation that intensified with movement and eased slightly with rest. Objectively, her baseline pain score was 7 on the NRS (severe pain), with

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a blood pressure of 92/61 mmHg and a pulse rate of 104 beats per minute; she was observed grimacing, restless, and guarding the surgical wound. Laboratory findings showed elevated leukocytes (13.80 × 10^3/µL), neutrophils (78.5%), and C-reactive protein (32.4 mg/L), consistent with an acute post-surgical inflammatory response. This clinical profile aligns closely with the major diagnostic indicators of acute pain specified in the Indonesian Nursing Diagnosis Standards (SDKI) pain complaint, grimacing, protective behavior, restlessness, and physiological change and mirrors prior reports describing post-appendectomy pain as one of the most consistent early symptoms after this procedure, frequently compounded by disturbed rest and heightened anxiety. On this basis, the nursing diagnosis of acute pain related to a physical injury agent (post-appendectomy procedure) was established, and a pain-management plan combining observational, therapeutic, educational, and collaborative interventions was initiated in accordance with the Indonesian Nursing Intervention Standards (SIKI), with SDB serving as the primary therapeutic, non-pharmacological component.

Table 1 summarizes the pre-test and post-test comparison across the three-day intervention period, and Figure 1 plots the corresponding trend in pain intensity and pulse rate. Following the first SDB session, pain intensity fell from 7 to 6, grimacing lessened, and pulse rate dropped from 104 to 95 beats per minute, although the patient still required repeated guidance to complete the breathing cycle correctly, consistent with pain-related difficulty sustaining attention on a novel task. By the second session, she performed SDB with greater independence; pain intensity declined further to 5, restlessness diminished, and pulse rate settled at 92 beats per minute, while she reported that movement-related pain persisted but felt more manageable. By the third session, the improvement was unmistakable: pain intensity reached 3 (mild), grimacing was no longer observed at rest, protective behavior resolved, and vital signs normalized (pulse rate 87 beats per minute; blood pressure 96/63 mmHg), with the patient able to perform light activity without apparent distress.

Table 1. Pre-Test and Post-Test Comparison of Pain Intensity and Clinical Indicators Across the Three-Day Slow Deep Breathing Intervention (Patient Ny. U)

Assessment Point	NRS Pain Score (0–10)	Pulse Rate (bpm)	Blood Pressure (mmHg)	Grimacing	Restlessness	Protective Behavior
Pre-intervention (Day 1, baseline)	7 (severe)	104	92/61	Present	Present	Present
Post-session Day 1	6 (moderate)	95	not re-recorded*	Reduced	Present	Present
Post-session Day 2	5 (moderate)	92	not re-recorded*	Reduced	Reduced	Reduced
Post-session Day 3	3 (mild)	87	96/63	Absent	Absent	Absent

**Blood pressure was recorded per ward protocol at baseline and final evaluation; pulse rate was monitored at every session as the principal continuous vital-sign indicator.*

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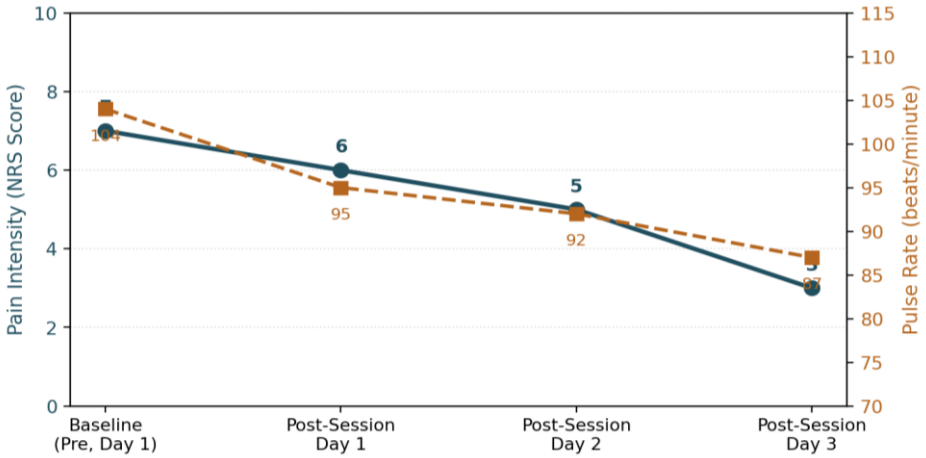

Figure 1. Trend of Pain Intensity (NRS) and Pulse Rate Across the Three-Day Slow Deep Breathing Intervention

This day-over-day pattern is not simply a numerical decline; it traces a physiologically coherent story. Melzack and Wall's Gate Control Theory of pain (1965) frames the spinal dorsal horn as a modulatable gate, where the relative balance of large- versus small-diameter afferent input, together with descending inhibitory signals from higher centers, determines how much nociceptive traffic reaches conscious perception ("Case Study of Deep Breath Relaxation Intervention to Reduce Chronic Pain Scale in Post-Brachial Tumor Surgery Patients," 2023; Trisna et al., 2024). Slow, paced breathing plausibly engages this gate from two directions at once: peripherally, rhythmic diaphragmatic movement and vagal afferent stimulation activate parasympathetic outflow, lowering heart rate and easing the sympathetic arousal that otherwise amplifies pain signaling; centrally, the deliberate, attention-demanding pacing of inhalation, breath-hold, and prolonged exhalation appears to recruit descending inhibitory pathways associated with relaxation and endorphin release. Read through this lens, the first-day plateau at NRS 6 is not a failure of the technique but an expected feature of gate modulation still being learned; the gate narrows further, and more reliably, once the motor sequence becomes automatic by day two and day three. Kolcaba's Comfort Theory offers a complementary, more holistic reading of the same data: the resolution of grimacing and restlessness alongside pain reduction reflects gains not only in physical relief but in the broader states of ease and, by the third day, the patient's return to light activity suggests a measure of transcendence the ability to function despite residual discomfort that a pain score alone does not fully capture.

These findings sit comfortably alongside the existing evidence base. Reported reduced pain during and after chest tube removal following SDB relaxation exercises, and documented a comparable effect of deep-breathing relaxation on post-appendectomy pain in an Indonesian surgical population. More directly, both described meaningful pain reduction with SDB specifically in post-appendectomy patients, and similarly reported pain relief when deep-breathing relaxation was combined with lavender aromatherapy in the same clinical population (Leung et al., 2024; Niyonkuru et al., 2024). The consistency across these independent reports spanning different hospitals, patient groups, and study designs strengthens confidence that the pattern observed in Ny. U reflects a genuine, reproducible clinical response rather than an isolated or coincidental finding. At the same time, this study cannot claim that SDB alone produced the observed improvement. Ny. U also received scheduled analgesics and antibiotics throughout the three-day period as part of routine post-operative care, and pharmacological analgesia almost certainly contributed to the decline in pain intensity.

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Rather than treating this as a threat to the findings, it is more accurate to read the two forms of care as working together: pharmacological treatment addresses the underlying inflammatory and nociceptive process directly, while SDB, through the gate-modulating mechanism described above, appears to lower the perceptual and autonomic amplification of that same signal. For bedside practice, this suggests that SDB is best positioned not as a replacement for analgesia but as a structured, nurse-led adjunct that patients can initiate independently between medication doses, extending pain relief coverage without additional pharmacological burden a genuinely low-cost, low-risk addition to standard surgical ward protocols that requires only nurse time and patient willingness to implement.

Figure 2. Implementation of Slow Deep Breathing Therapy with Patient Ny. U, Day 1 to Day 3

Several limitations temper how far these findings can be generalized. As a single-case, one-group design without a comparison patient or control condition, this study cannot statistically isolate the independent effect of SDB from the concurrent pharmacological treatment Ny. U received, nor can a three-day observation window speak to whether the improvement would be sustained after discharge or replicate across patients with different pain thresholds, comorbidities, or surgical complexity; pain and behavioral indicators were also assessed by the treating nurse rather than a blinded observer, introducing a modest risk of expectation-driven bias, and the absence of a formal fidelity check on independent home-based practice means the third-day gains attributed partly to autonomous SDB use rest on self-report rather than direct observation. These constraints are inherent to the case-study format and do not undermine the internal coherence of the observed trend, but they do mean the findings should be read as hypothesis-generating description rather than confirmatory evidence of efficacy.

CONCLUSION

A gate that narrows a little more each day is, in the end, the simplest way to describe what happened to Ny. U: three days of guided slow deep breathing accompanied a fall in pain intensity from severe (NRS 7) to mild (NRS 3), a pulse rate that settled from 104 to 87 beats per minute, and the disappearance of grimacing, restlessness, and protective behavior that had marked her first post-operative day, evidence consistent with Gate Control Theory's account of breathing-mediated modulation of nociceptive transmission and with Comfort Theory's broader picture of relief, ease, and returning function. Read together with prior reports in comparable surgical populations, this case supports positioning SDB as a reproducible, nurse-initiated adjunct to pharmacological analgesia

rather than a stand-alone substitute for it, one that surgical wards can build into standard post-appendectomy care through brief bedside teaching and dedicated practice time on the first post-operative day, when patients need the most guidance and stand to gain the most. Future work with larger samples, comparison groups, and longer follow-up would help establish how much of this gate-narrowing effect persists once patients return home, and whether earlier, more structured SDB teaching changes the broader trajectory of post-appendectomy recovery.

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Conflict of Interest

The authors declare no conflict of interest regarding the publication of this article.

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