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RESEARCH ARTICLE

The Effect of Capsicum on Postoperative Patients: A Systematic Review

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ABSTRACT

This systematic review aimed to investigate the effects of capsicum plaster therapy on post-surgical patients. A comprehensive literature search was conducted in PubMed, CINAHL, Ovid Medline, Cochrane Library, KoreaMed, KMbase, KISS, and RISS databases using relevant search terms. The review included randomized studies of post-surgical patients who received capsicum plaster therapy. The extracted literature was evaluated using the quality appraisal checklist of ROB 2 (Risk of Bias 2.0) and visualized using a risk-of-bias visualization tool. The review included 12 randomized controlled studies. The results showed that capsicum plaster therapy was effective in reducing post-surgical nausea, vomiting, and pain, with some impact on postoperative side effects. Interventions using capsicum plaster to reduce the incidence of nausea, manage postoperative pain, reduce PCA usage, and minimize additional analgesic requirements might be beneficial for postoperative patient care. Healthcare professionals should consider incorporating capsicum plaster therapy into postoperative care protocols to improve pain management outcomes. Further research should aim to standardize the application methods, sizes, and timing of capsicum plaster interventions to produce more consistent and generalizable results. This will help validate the efficacy of capsicum plaster therapy and optimize its application in diverse healthcare settings.

INTRODUCTION

Significance of the Research:

The number of patients undergoing surgery is constantly increasing as medical technology and systems enable early detection of diseases. According to Statistics Korea's Major Surgery Statistics Yearbook in 2022, the number of surgeries increased at an average annual rate of 2.5%, from 1.87 million in 2018 to 2.06 million in 2022, and the cost of surgical care increased at an average annual rate of 8.2%, from KRW 5.897 trillion in 2018 to KRW 8.823 trillion in 2022 (Statistics Korea, 2022). Surgery causes various physical reactions in patients, including postoperative nausea and vomiting (PONV), pain, surgical site infection, and atelectasis (He et al., 2022; Park et al., 2020). Postoperative nausea and vomiting are relatively common, typically occurring within 24 hours of surgery (Gan et al., 2020). It has been reported that about 30% of surgical patients experience postoperative nausea and vomiting, and about 80% of patients undergoing high-risk surgeries such as laparoscopic surgery and gynecologic surgery experience postoperative nausea and vomiting (Park et al., 2020). Pain is a risk factor for postoperative nausea and vomiting, and these painful experiences delay patients' recovery (Gan et al., 2020). They also prolong patients' postoperative hospital stays and contribute to increased healthcare costs (Jin et al., 2020). Pharmacologic interventions are common in surgical patients to promote recovery and prevent

complications, but they can have side effects such as drowsiness, diarrhea, and fever (Geum et al., 2022; Gudsoorkar & Quigley, 2020). Complementary and alternative therapies have been used in surgical patients as a safe way to mitigate complications and minimize side effects in conjunction with pharmacotherapy (Zheng et al., 2023). Aromatherapy (Hwang & Kwon, 2021), music therapy (Uğraş et al., 2018), warmth therapy (Lee, 2020), and chili pepper paste therapy (Jeong & Jung, 2024; Kim et al., 2016) have been used to reduce nausea, vomiting, pain, stress, and blood pressure in postoperative patients.

The intervention to be examined in this study is the use of red pepper paste therapy, which is inexpensive and known to be effective in treating muscle and joint pain (Lee et al., 2005). Red pepper paste therapy was first developed by the Namsan monk as an alternative to acupuncture for the treatment of pain and disease (Namsan, 1999). Red pepper paste is characterized by being made of various types of plasters that can be easily attached. Company S's red pepper paste contains 180 mg of red pepper powder and 18 mg of red pepper tincture per sheet (8.4 x 12.4 cm^2) and can be applied to the affected area several times a day (Jung & Park, 2013; Lee et al., 2005). In addition, Capsicum paste contains 0.49 mg of methyl salicylate and 1.64 mg of Capsicum tincture in a round piece of paper with a radius of 1.1 cm and an area of 0.95 cm^2 (Kim et al., 2016). In the literature, most studies have shown positive results, such as the application of capsicum to resin needle acupressure points in knee replacement patients for pain control and reduced incidence of nausea and vomiting (Lee et al., 2005) and the application of capsicum to thyroidectomy patients for vomiting and nausea with lower frequency (Koo et al., 2013). If therapy with capsicum pads is effective in reducing postoperative complications in patients, it would be a suitable intervention for postoperative patient care. However, there is a lack of evidence for its application in nursing practice due to the variation in application sites and application times in previous studies. Therefore, through a systematic review, this study aimed to determine the effectiveness of various forms of capsicum therapy on postoperative pain, nausea, and vomiting, and to provide evidence for nursing research by examining the characteristics of the intervention methods, and to provide direction for intervention practice for postoperative patients.

Study Purpose

The purpose of this study is to systematically review experimental studies on the effects of capsicum-based therapy on postoperative patients, analyze the methods and characteristics of the interventions, and evaluate their efficacy. The specific aims of the study were to:

1. Identify the general characteristics of studies of therapy with capsicum in postoperative patients.
2. Analyze the interventions in studies using capsicum for postoperative patients.
3. Analyze the effectiveness of capsicum therapy in postoperative patients.

Research Methods

Research Design

This systematic review study analyzed the literature on therapies using capsicum for postoperative patients to identify the characteristics of effective interventions and to determine the evidence for their effectiveness. The procedures and results of this study were described utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher et al., 2009).

Criteria for Selecting Papers to Analyze

The inclusion criteria were as per PICO-SD (Participants, Intervention, Comparison, Outcomes, Study Design): (1) postoperative patients (P), (2) therapy with capsicum (I), (3) the control group will be either a sham control group (Sham) or a no-stimulus intervention (placebo) at a different point than the intervention group (C), (4) the intervention will have an effect on postoperative patients (O), and (5) the study design will be a randomized controlled trial (SD). Exclusion criteria

were: studies not in English or Korean, abstracts presented at conferences, gray literature, systematic reviews, full text not available, and gender-specific interventions.

Literature Search and Selection Process

The data search was conducted in April 2024, with no specific time limit. The domestic databases were Korea Medical Journal (KoreaMed), Korean Medical Article Database (KMbase), Research Information Sharing Service (RISS), and Korean Studies Information Service System (KISS), and the international databases were PubMed, Cumulative Index to Nursing & Allied Health Literature (CINAHL), Ovid Medline, and Cochrane Library. The search terms were selected by checking MeSH terms through PubMed searches and selecting relevant terms and synonyms. The key terms for domestic databases were ('surgery' OR 'treatment' OR 'therapy') AND ('capsicum plaster'), and the key terms for international databases were ('surgery' OR 'treat' OR 'therapy' OR 'post operation' OR 'post surgery' OR 'postsurgical' OR 'postoperative' OR 'after operation' OR 'after surgical') AND ('capsicum plaster'). The retrieved articles were organized using EndNote Web and Microsoft's Excel 2023. Among the retrieved articles, duplicates were removed, titles and abstracts were reviewed for primary categorization according to the inclusion and exclusion criteria, and finally, full text was reviewed to exclude articles that did not meet the inclusion criteria and selected for final analysis.

Evaluating the Quality of the Literature

The quality of the literature selected for this study was assessed using the Cochrane Collaboration's Revised Cochrane risk of bias tool for randomized trials (RoB 2.0) (Sterne et al., 2019). The RoB 2.0 includes five domains of bias: randomization process, deviation from the intended intervention, missing outcome data, measurement of the outcome, and selection of the reported outcome. The quality assessment was conducted independently by two authors (first author, corresponding author) and discussed and agreed upon when there was disagreement between the authors. The risk of bias was assessed as 'low', 'some concerns' or 'high' based on the assessment algorithm for each domain. The results of the RoB 2.0 assessment were visualized in traffic light charts and bar charts in the Risk-of-bias VISualization (robvis).

Extracting and Analyzing Data

The general characteristics (first author, publication year, country, surgery name, number of subjects), intervention method (experimental intervention, control intervention, start time, end time, application site, application size), and intervention outcome (primary outcome variable, secondary outcome variable, intervention effect) were extracted and analyzed for the 12 selected articles.

Research Findings

Literature Selection Results

The selection of the study was decided after two authors independently reviewed the article. According to the literature selection criteria, 5 KoreaMed, 1 KMbase, 4 RISS, and 1 KISS articles were searched in the database for domestic articles, and 1 PubMed, 6 CINAHL, 40 Ovid Medline, and 21 Cochrane Library articles were searched for international articles, totaling 79 articles. After excluding 20 duplicates, we reviewed the titles and abstracts of 59 articles and excluded 42 articles that did not meet the inclusion criteria, including 21 articles that did not meet the inclusion criteria of the study subjects, 17 articles that did not involve therapeutic interventions using capsicum, 1 article that did not have a randomized controlled trial design, 2 literature reviews, and 1 study that divided the intervention by gender, and 5 articles for which the full text was not available, and selected 12 final articles (Figure 1, Appendix).

Results of the Paper Quality Assessment

We conducted a quality assessment of the 12 finalized studies using RoB 2.0. Based on the quality assessment of the 12 finalized studies, 10 (83%) studies with a sufficient description of the

randomization process were judged to be 'low risk', and 2 (17%) studies that did not mention the exact method of randomization were judged to have 'some concerns'. We assessed 11 studies (92%) as having a low risk of bias due to the allocated intervention and 1 study (8%) as having a high risk because there was no information on whether participants and interventionists were aware of the allocated intervention. Seven studies (58%) were rated as 'low risk' because missing outcome data did not result in missing values, two studies (17%) were rated as 'some concerns' because missing values occurred but were not corrected for skew, and three studies (25%) were rated as 'high risk' because no explanation for missing outcome data was described. In the outcome measures domain, 12 studies (100%) mentioned blinding of outcome assessors, all of which were rated as low risk. For selective reporting, 12 studies (100%) presented results according to a pre-specified protocol, all of which were rated as low risk. The overall risk of bias assessment by the RoB 2.0 algorithm resulted in 6 studies (50%) being judged as 'low risk' in all domains, 2 studies (17%) being judged as 'some concern' with 'some concern' in at least one domain but not 'high risk', and 4 studies (33%) being judged as 'high risk' (Figure 2).

Analyzing the Literature

Characteristics of the Analyzed Literature

The following table summarizes the results of the analysis of 12 studies in which postoperative patients were treated with capsicum plaster in terms of general characteristics, intervention method (experimental intervention, control intervention, start time of intervention, end time of intervention, application site, and size of application), and intervention outcomes (Table 1).

(1) General Characteristics of the Analyzed Literature

The year of publication of the 12 analyzed studies was divided into 7 (58%) studies published before 2010 (Kim et al., 2002; Kim et al., 2006b; Kim et al., 2009; Kim & Nam, 2006a; Lee et al., 2005; Misra et al., 2005; Park et al., 2004) and 5 (42%) studies published after 2010 (Acar et al., 2012; Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2016; Koo et al., 2013). Korea was the most common country with 10 studies (83%) (Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2002; Kim et al., 2006b; Kim et al., 2009; Kim et al., 2016; Kim & Nam, 2006a; Koo et al., 2013; Lee et al., 2005; Park et al., 2004), followed by Turkey (Acar et al., 2012) and India (Misra et al., 2005) with one study each.

The most common surgical procedure in the study was abdominal hysterectomy with 3 (25%) (Kim et al., 2002; Kim & Nam, 2006a; Park et al., 2004), followed by tonsil adenoidectomy (Acar et al., 2012), mastectomy (Jeong & Jung, 2024), gynecologic laparoscopic surgery (Jung & Park, 2013), endoscopic sinus surgery (Kim et al, 2016), inguinal hernia surgery (Kim et al., 2006b), orthognathic surgery (Kim et al., 2009), thyroid surgery (Koo et al., 2013), total knee arthroplasty (Lee et al., 2005), and otitis media surgery (Misra et al., 2005). The size of the intervention and control groups was identified as 40 or fewer subjects in seven studies (58%) (Acar et al., 2012; Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2006b; Kim et al., 2009; Kim & Nam, 2006a; Misra et al., 2005) and 41 or more subjects in five studies (42%) (Kim et al., 2002; Kim et al., 2016; Koo et al., 2013; Lee et al., 2005; Park et al., 2004).

Characteristics of the Arbitration Method

The interventions in this study were applied to both hands, wrists, and legs by applying chili pads, which were selected as the application sites for acupuncture. Among the acupuncture interventions, 7 studies (58%) used Korean hand acupuncture and were applied to both hands. The resin acupuncture points were K-D2 in 4 studies (33%) (Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2002; Koo et al., 2013), LI 4 in 1 study (Kim et al., 2009), K-M26 in 1 study (Lee et al., 2005), and K-A20 in 1 study (Park et al., 2004), where red pepper paste was applied to each acupuncture point. Bilateral wrist was applied in 3 studies (25%), acupuncture point P6 was applied in 2 studies (Kim et al., 2016; Misra et al., 2005), HT7 in 1 study (Acar et al., 2012), and

ST36 in 2 studies (17%) (Kim et al., 2006b; Kim & Nam, 2006a), and bilateral leg was applied in 2 studies (17%) (Kim et al., 2006b; Kim & Nam, 2006a).

In terms of the size of the pepper plasters used in the intervention group, nine studies (75%) used 0.5x0.5 cm^2 (Acar et al., 2012; Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2009; Kim & Nam, 2006a; Lee et al., 2005; Park et al., 2004), two studies (17%) used 1.1x0.95 cm^2 (Kim et al., 2016; Koo et al., 2013), and one study (8%) used 1x1 cm^2 (Misra et al., 2005). Seven studies (58%) applied red pepper paste to a different site than the intervention in the control group (Kim et al., 2002; Kim et al., 2006b; Kim et al., 2009; Kim et al., 2016; Kim & Nam, 2006a; Koo et al., 2013; Park et al., 2004), and five studies (42%) applied a paste without capsicum in the same application area as the intervention group (Acar et al., 2012; Jeong & Jung, 2024; Jung & Park, 2013; Lee et al., 2005; Misra et al., 2005). As for the timing of the intervention, all studies applied it before anesthesia, with 10 studies (83%) applying it 30 min before anesthesia (Acar et al., 2012; Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2009; Kim & Nam, 2006a; Koo et al., 2013; Misra et al., 2005; Park et al., 2004), and the rest were conducted immediately before anesthesia (Kim et al., 2016) and 480 min before anesthesia (Lee et al., 2005). The endpoint of the intervention was 8 hours after surgery in seven studies (58%) (Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2009; Kim et al., 2016; Kim & Nam, 2006a; Koo et al., 2013; Park et al., 2004), followed by 3 (25%) after 72 hours (Kim et al., 2009; Kim & Nam, 2006a; Lee et al., 2005) and 1 (8%) after 6 hours (Misra et al., 2005).

Analyze the Effectiveness of the Intervention

In the analysis of intervention effects, the primary outcomes were nausea, vomiting, pain, and adverse events. The effect on postoperative nausea was categorized into nausea incidence and nausea intensity, and 10 studies measured the effect of nausea. Six studies (60%) (Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2009; Kim et al., 2016; Kim & Nam, 2006a; Koo et al., 2013) showed a significant difference in the incidence of postoperative nausea, and four studies (40%) (Kim et al., 2002; Lee et al., 2005; Misra et al., 2005; Park et al., 2004) showed no significant difference. Three studies measured postoperative nausea intensity (Jeong & Jung, 2024; Jung & Park, 2013; Koo et al., 2013), and postoperative nausea intensity was significantly reduced in two studies (67%) (Jeong & Jung, 2024; Koo et al., 2013). All 12 studies measured the effect on the incidence of postoperative vomiting, with four studies (33%) showing a significant reduction in postoperative vomiting (Kim et al., 2009; Kim et al., 2016; Kim & Nam, 2006a; Koo et al., 2013), and 8 studies (67%) showed no significant difference (Acar et al., 2012; Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2002; Kim et al., 2006b; Lee et al., 2005; Misra et al., 2005; Park et al., 2004).

Postoperative pain was measured in six studies, with three (50%) (Kim et al., 2006b; Kim et al., 2009; Kim & Nam, 2006a) finding a reduction in pain after the intervention, and one (Acar et al., 2012) finding a reduction in pain scores but no significant difference.

Looking at the effect on postoperative adverse events, five studies were identified in this study, and postoperative adverse events were identified as nausea (Acar et al., 2012; Kim et al., 2006b), laryngospasm (Acar et al., 2012), urinary retention (Kim & Nam, 2006a), pruritus (Kim et al., 2009; Kim & Nam, 2006a; Lee et al., 2005), and sedation (Lee et al., 2005). After the intervention, there was a significant reduction in one study that identified urinary retention (Kim & Nam, 2006a) and a significant difference in two of the three studies that identified pruritus (67%) (Kim et al., 2009; Kim & Nam, 2006a).

Secondary outcomes were categorized by the extent of postoperative PCA use, whether additional analgesia was given, and whether antiemetics were given. Postoperative PCA use was measured in terms of dose and frequency of use, and of the four studies that measured the dose of PCA use, three (75%) found a significant reduction in the intervention group compared to the control group (Jeong & Jung, 2024; Kim et al., 2009; Kim & Nam, 2006a). Frequency of PCA use was measured in three studies, with two studies (67%) finding a significant reduction in PCA use in the intervention

group compared to the control group (Kim et al., 2009; Kim & Nam, 2006a). The use of additional analgesics was identified in six studies, with four studies (67%) showing a significant reduction in the frequency of additional analgesics (Jeong & Jung, 2024; Kim et al., 2009; Kim & Nam, 2006a; Lee et al., 2005). The use of anti-nausea medications was measured in seven studies, with three (43%) studies showing a significant reduction in anti-nausea medication use in the intervention group compared to the control group (Kim et al., 2009; Kim et al., 2016; Koo et al., 2013) and four (57%) studies showing no statistical effect in reducing the frequency of anti-nausea medication use (Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2002; Misra et al., 2005).

DISCUSSION

This study was conducted to systematically review 12 RCTs to analyze the effectiveness of capsicum therapy in postoperative patients and to provide a basis for future interventions to reduce complications in postoperative patients.

The quality assessment of the 12 finalized studies showed that 10 (83%) were rated as 'low risk' in the randomization process domain, 11 (92%) were rated as 'low risk' in the deviation from the assigned intervention domain, and 7 (58%) were rated as 'low risk' in the missing outcome data domain. All 12 studies (100%) were rated as 'low risk' in the outcome measures and optional reporting domains. The overall risk of bias assessment resulted in 6 studies (50%) judged as 'low risk' across all domains, 2 studies (17%) judged as 'some concerns', and 4 studies (33%) judged as 'high risk'. The quality assessment identified a high risk of bias in the area of missing outcomes. This was explained by a lack of clarity on the handling of missing data for dropped subjects. Missing data in studies has a significant impact on the reliability of the results, and studies that fail to address missing data should be interpreted with caution. We recommend that future studies should report on missing data in their results in detail.

Of the 12 studies analyzed, 7 (58%) were published before 2010, while 5 (42%) were published after 2010. This suggests that less attention has been paid to capsicum, and it has been reported that more recent studies have focused on oral or injectable drugs, which are easier to use (Park et al., 2024). As capsicum has the advantage of being inexpensive and easy to use with few side effects (Jeong & Jung, 2024), it is expected that more studies will be conducted to verify its effectiveness. South Korea had the most studies with 10 (83%), followed by Turkey and India with one each. In these countries, it is believed that other traditional treatments or modern medical methods are more commonly used instead of capsicum, and since capsaicin, the main ingredient of capsicum, is derived from chili peppers commonly used in Korean cuisine, the cultural background may have influenced the activation of research. Therefore, it is necessary to investigate the effectiveness of capsicum in various countries, and research cooperation and support between countries should be made for this purpose.

Abdominal hysterectomy was the most common surgical procedure, with three studies (25%), followed by tonsillectomy, mastectomy, gynecologic laparoscopic surgery, endoscopic sinus surgery, inguinal hernia surgery, orthognathic surgery, thyroid surgery, total knee replacement, and otitis media. Across the different postoperative applications of capsicum, the majority of studies found that capsicum was effective in reducing nausea (60%), suggesting that it can be used universally to manage nausea regardless of the type of surgery. Replication studies are needed to provide more effective capsicum interventions for postoperative patients.

The literature analyzed in this study showed a variety of sites and acupuncture points for applying capsicum plasters. In particular, 7 studies (58%) used Korean hand acupuncture, and most of them applied capsicum plasters to both hands. The K-D2 acupuncture point was the most common with four studies (33%), followed by LI4, K-M26, and K-A20 with one study each. On both wrists, two studies (17%) primarily used P6 and one study (8%) used HT7, and two studies (17%) used ST36 on both legs. These differences in acupuncture points play an important role in relieving pain, nausea, and vomiting. The K-D2 acupoint is known to be effective for digestive-related symptoms, and P6 has been reported to be effective in relieving nausea and vomiting (Yoo & Oh,

2015). Therefore, the choice of acupoints can have an important impact on the effectiveness of the intervention (Lin et al., 2022), and the attachment of capsicum plaster in resin needle therapy should be applied differently depending on the acupoints. This suggests that it is important to select appropriate acupuncture points according to the patient's condition and symptoms.

The size of the pepper paste was also analyzed as a factor affecting the intervention effect. Nine studies (75%) used chili peppers measuring 0.5x0.5 cm^2, followed by two studies (17%) using 1.1x0.95 cm^2 and one study (8%) using 1x1 cm^2. The size of the chili peppers is closely related to the amount of capsaicin delivered to the skin. Larger capsicum plasters deliver more capsaicin and may provide stronger pain relief but may also increase the risk of side effects (Mankowski et al., 2017). On the other hand, smaller capsicum plasters may be easier to apply and have fewer side effects but may be less effective. In this study, 0.5x0.5cm^2 capsicum plasters were most used, which seems to be a good choice for balancing effectiveness and side effects. However, further research is needed to clarify the differences in effectiveness based on size.

Ten studies (83%) started the capsicum intervention 30 minutes before anesthesia, one (8%) immediately before anesthesia, and one (8%) 480 minutes before anesthesia. The end point of the intervention was 8 hours after surgery in 7 studies (58%), followed by 72 hours in 3 studies (25%) and 6 hours in 1 study (8%). The timing of the intervention has a significant impact on the effectiveness of capsaicin. If applied 30 minutes before anesthesia, the effects of capsaicin may reach their maximum during and immediately after surgery, making it effective in relieving pain, nausea, and vomiting (Mankowski et al., 2017). On the other hand, the duration and intensity of the effect may vary if applied immediately before anesthesia or 480 minutes before anesthesia. The timing of the end of the capsaicin intervention also affects the effect. Most studies removed capsicum 8 hours after surgery, reflecting the fact that pain, nausea, and vomiting relief is most needed in the early postoperative period (Mankowski et al., 2017). Removal after 72 hours was an attempt to increase the duration of effect through a longer application time; however, it should be noted that side effects such as skin irritation and rash may increase with longer duration of the intervention.

In conclusion, the site of application, acupuncture points, size, and timing of the start and end of the intervention are all important factors that affect the effectiveness of the intervention. Considering this, a customized intervention plan tailored to the patient's condition and needs is necessary, and further research should be conducted to optimize these factors.

Of the 10 studies that measured the effect of postoperative nausea, 6 studies (60%) showed a decrease in nausea incidence after the intervention with capsicum. This suggests that the capsaicin component of capsicum is effective in modulating the activity of serotonin (5-HT) receptors to reduce the neural response that causes nausea (Xiang et al., 2022). Four studies (40%) did not show a significant difference in the reduction of nausea incidence after capsicum intervention, which is believed to be due to differences in the intervention method, such as the application method and pretreatment. The study in which lorazepam was administered to all subjects before the experiment (Misra et al., 2005) did not show a significant difference in nausea incidence between the capsicum intervention group and the control group due to its sedative effect. In addition, in the remaining three studies where the reduction in nausea was not significant, differences in subject characteristics such as patient health status may have influenced the effect of capsicum. Of the three studies that measured postoperative nausea intensity, postoperative nausea intensity was significantly reduced in two (67%) of the studies. On the other hand, Jung & Park (2013) found no significant difference in nausea intensity reduction, which may be due to the use of capsicum in combination with prophylactic antiemetics. This combination method may induce different physiologic responses than monotherapy (Lee & Kim, 2018) and may make it difficult to clearly identify the effect of capsicum. Future studies should be controlled for differences in patient characteristics, surgical methods, and repeated measures.

Twelve studies measured the effect on postoperative vomiting, and the incidence of postoperative vomiting was significantly reduced in four (33%) of the studies after the capsaicin intervention. This may be explained by the fact that capsaicin in capsicum inhibits the vomiting reflex by modulating the interaction of the central and peripheral nervous systems through TRPV1 (Transient Receptor Potential Vanilloid 1) and serotonin (5-HT3) receptors (Xiang et al., 2022).

Eight studies (67%) showed no significant difference in the incidence of postoperative vomiting, which may be due to the lack of significant difference in the effectiveness of the intervention in studies where the control group was given antiemetics (Jeong & Jung, 2024; Jung & Park, 2013) and differences in the characteristics of the subjects in studies involving pediatric patients (Acar et al., 2012; Kim et al., 2006b). In addition, differences in vomiting incidence may be influenced by physical and psychological conditions (Hwang & Hur, 2020). Although there were some positive effects on the incidence of vomiting after the capsicum intervention, there was generally no significant reduction. This may be due to a combination of factors, and it is necessary to unify the characteristics of the study group, the type of surgery, and standardize the application of acupuncture points in future studies, considering the study design, characteristics of the subjects, psychological factors, and the site and method of application.

Of the six studies that addressed postoperative pain, three (50%) found significant reductions in pain after the capsicum intervention. These findings support the capsaicin component of chili peppers as an effective pain reliever. Capsaicin is known to relieve pain by activating the TRPV1 receptor, which inhibits pain signaling (Giaccari et al., 2021). On the other hand, a study by Acar et al. (2012) found a reduction in pain scores, but the difference was not statistically significant. This suggests that results may vary depending on the methodology and characteristics of thestudy population. The effectiveness of pain interventions may also depend on the individual's pain sensitivity, how the intervention is applied, and how long it is applied (Muñoz-Leyva et al., 2020). While pain interventions using chili peppers have generally shown positive results, some studies have not shown as much effect as expected. This suggests that the effects may vary depending on the method and time of application, as well as the characteristics of the subjects. Therefore, future studies need more precise study designs that take these variables into account (Giaccari et al., 2021).

In this study, five studies showed postoperative adverse events, and one study showed a significant reduction in urinary retention after the intervention. Paresthesia is caused by postoperative pain and the use of anticholinergic drugs, and capsicum may be effective in reducing paresthesia by inducing muscle relaxation through pain relief and improved blood flow (Hwang, 2021). Two of the three studies that looked at pruritus showed significant differences (67%), suggesting that capsaicin in chili peppers may reduce itching by desensitizing cutaneous nerves through TRPV1 receptors (Xiang et al., 2022). One (33%) study (Lee et al., 2005) showed a decrease in pruritus in the intervention group, but not significantly different from the control group. In addition, no significant differences were found in the effects on nausea, laryngospasm, and sedation after capsicum intervention. Nausea often occurs during anesthesia and the early recovery phase within 2 hours of surgery (Gan et al., 2020), and this study measured at 24 hours postoperatively, which may explain the lack of significant differences. Laryngospasm may be caused by issues related to anesthetic agents or airway management and is thought to be less directly related to the mechanism of action of capsicum (Lee & Sung, 2023). Sedation is more closely related to the effectiveness of the anesthetic (Kang et al., 2023), and since capsicum primarily acts to relieve localized pain, it may have been limited in its ability to produce systemic sedation. Therefore, we suggest that variables of postoperative adverse events in future interventions using capsicum should include urinary retention and pruritus.

In studies related to postoperative patient-controlled analgesia (PCA) use, three of the four studies (75%) that measured PCA use showed a significant reduction in PCA use in the intervention group. This suggests that the capsicum intervention is effective in reducing postoperative pain. One study (Lee et al., 2005) found no significant difference in PCA use, suggesting that the effectiveness of the intervention may be inconsistent. For frequency of PCA use, two of the three studies (67%) found a significant decrease in PCA use in the intervention group, suggesting that the capsicum intervention may have a positive impact on patients' pain management by reducing PCA use. Four of the six studies (67%) that looked at additional pain medication use showed a significant reduction in the frequency of additional pain medication in the intervention group. This suggests that the capsicum intervention may help reduce the use of additional pain medications. However, the remaining two studies (Kim et al., 2002; Park et al., 2004) did not find a significant difference. This suggests that the results may be due to differences in study methods and populations. Regarding the use of anti-nausea medication, three of the seven studies (43%) found a significant decrease in anti-nausea medication use in the intervention group, while the remaining four studies (Jeong & Jung, 2024; Jung & Park, 2013; Kim et al., 2002; Misra et al., 2005) found no statistically significant difference. This suggests that the effect of the intervention is inconsistent in the use of antitussive agents, and further research is needed. In conclusion, the capsicum intervention may be effective in reducing the amount and frequency of postoperative PCA use and additional analgesic use. However, the effect on antiemetics use is inconsistent and warrants further study. These findings suggest that capsicum interventions may contribute to improved postoperative pain management and reduced medication use, and future studies are needed to provide more definitive evidence.

This study conducted a systematic review to analyze the effectiveness of capsicum interventions in postoperative patients. Limitations of this study include the fact that most of the studies analyzed were conducted in Korea, which limits the generalizability of the results to other countries and different populations. In addition, the variability of the intervention methods, including the site of application, acupuncture points, size, and start and end time of the intervention, made it difficult to consistently compare the interactions between these variables, and therefore the effect sizes could not be pooled in a meta-analysis.

CONCLUSION AND RECOMMENDATIONS

This study systematically reviewed 12 randomized controlled trials to analyze the effectiveness of capsicum interventions in postoperative patients. The results showed that the intervention was effective in reducing the incidence of postoperative nausea, reducing pain, reducing the amount and frequency of PCA use, and reducing the use of additional analgesics. In particular, the reduction in PCA use and frequency suggested that the intervention was an important intervention to help manage postoperative pain. By confirming the effectiveness of non-drug interventions such as capsicum, we hope to provide a basis for suggesting drug-free postoperative complication management methods to reduce adverse drug reactions and provide safe complementary and alternative therapies for patients. In addition, the effectiveness of anti-nausea medications was inconsistent, indicating the need for further research. As most of the studies in this study were conducted in Korea, there were limitations in the generalizability of the results due to differences in cultural background and healthcare systems. Therefore, future studies should investigate the efficacy of the same intervention and standardize the application site, size, and timing of the start and end of the intervention to achieve more results that are consistent.

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APPENDIX

<Table 1> Characteristics of selected studies (N=12)

No.	1st author (year) / Region	Surgery	Sample size No. (I/C)	Intervention	Control	Start time (min)	End time (hr)	Applied point (acupoint)	Size (cm^2)	Primary outcomes	Secondary outcomes
1	Acar (2012)/ Turkey	Tonsillectomy/ Adenoidectomy	25/25	Acupuncture	Inactive plasters	30	ND	Both wrists (HT 7)	0.5×0.5	Incidence of vomiting (NS) Pain scores (NS) Side effects (NS) : Retching, Laryngospasm	
2	Jeong (2024)/ Korea	Mastectomy	37/34	Korean hand acupuncture	Inactive plasters	30	8	Both hands (K-D2)	0.5×0.5	Incidence of nausea ↓ Intensity of nausea ↓ Incidence of vomiting (NS) Pain scores (NS)	Rescue of antiemetic (NS) PCA dose ↓ Additional analgesics ↓
3	Jung (2013)/ Korea	Gynecologic Laparoscopy	34/34	Korean hand acupuncture	Inactive plasters	30	8	Both hands (K-D2)	0.5×0.5	Incidence of nausea ↓ Intensity of nausea (NS) Incidence of vomiting (NS)	Rescue of antiemetic (NS)
4	Kim (2016)/ Korea	Endoscopic sinus surgery	50/50	Acupuncture	Capsicum plasters	0	8	Both wrists (P6)	1.1x0.95	Incidence of nausea ↓ Incidence of vomiting ↓	Rescue of antiemetic ↓
5	Kim (2006a)/ Korea	Abdominal hysterectomy	30/30	Acupuncture	Capsicum plasters	30	72	Both legs (ST36)	0.5×0.5	Incidence of nausea ↓ Incidence of vomiting ↓ Pain scores ↓ Side effects ↓ : Urinary retention, Pruritus	PCA dose ↓ PCA requests ↓ Additional analgesics ↓

No.	1st author (year) / Region	Surgery	Sample size No. (I/C)	Intervention	Control	Start time (min)	End time (hr)	Applied point (acupoint)	Size (cm^2)	Primary outcomes	Secondary outcomes
6	Kim (2006b)/ Korea	Inguinal hernia repair	36/35	Acupuncture	Capsicum plasters	30	8	Both legs (ST36)	0.5×0.5	Incidence of vomiting (NS) Pain scores ↓ Side effects (NS) : Retching	
7	Kim (2009)/ Korea	Orthognathic Surgery	28/28	Korean hand acupuncture	Capsicum plasters	30	3	Both hands (LI 4)	0.5×0.5	Incidence of nausea ↓ Incidence of vomiting ↓ Pain scores ↓ Side effects ↓ : Pruritus	PCA dose ↓ PCA requests ↓ Additional analgesics ↓ Rescue of antiemetics ↓
8	Kim (2002)/ Korea	Abdominal hysterectomy	50/50	Korean hand acupuncture	Capsicum plasters	30	8	Both hands (K-D2)	0.5×0.5	Incidence of nausea (NS) Incidence of vomiting (NS)	Rescue of antiemetics (NS) Additional analgesics (NS)
9	Koo (2013)/ Korea	Thyroid operation	46/46	Korean hand acupuncture	Capsicum plasters	30	8	Both hands (K-D2)	1.1x0.95	Incidence of nausea ↓ Intensity of nausea ↓ Incidence of vomiting ↓	Rescue of antiemetics ↓
10	Lee (2005)/ Korea	Knee replacement	51/51	Korean hand acupuncture	Inactive plasters	480	72	Both hands (K-M26)	0.5×0.5	Incidence of nausea (NS) Incidence of vomiting (NS) Pain scores (NS) Side effects (NS) : Sedation, Pruritus	PCA dose (NS) PCA requests (NS) Additional analgesics ↓

No.	1st author (year) / Region	Surgery	Sample size No. (I/C)	Intervention	Control	Start time (min)	End time (hr)	Applied point (acupoint)	Size (cm^2)	Primary outcomes	Secondary outcomes
11	Misra (2005)/ India	Middle ear surgery	38/40	Acupuncture	Inactive plasters	30	6	Both wrists (P6)	1x1	Incidence of nausea (NS) Incidence of vomiting (NS)	Rescue of antiemetics (NS)
12	Park (2004)/ Korea	Abdominal hysterectomy	50/50	Korean hand acupuncture	Capsicum plasters	30	8	Both hands (K-A20)	0.5×0.5	Incidence of nausea (NS) Incidence of vomiting (NS)	Additional analgesics (NS)

I=Intervention group; C=Control group; ND=Not described; HT7=Heart 7; K-D2=Korean hand acupuncture D2; P6=Pericardium 6; ST36=Stomach 36; L14=Large intestine 14; K-M26=Korean medicine 26; K-A20=Korean acupuncture 20; NS=Not significant; PCA=Patient controlled analgesia

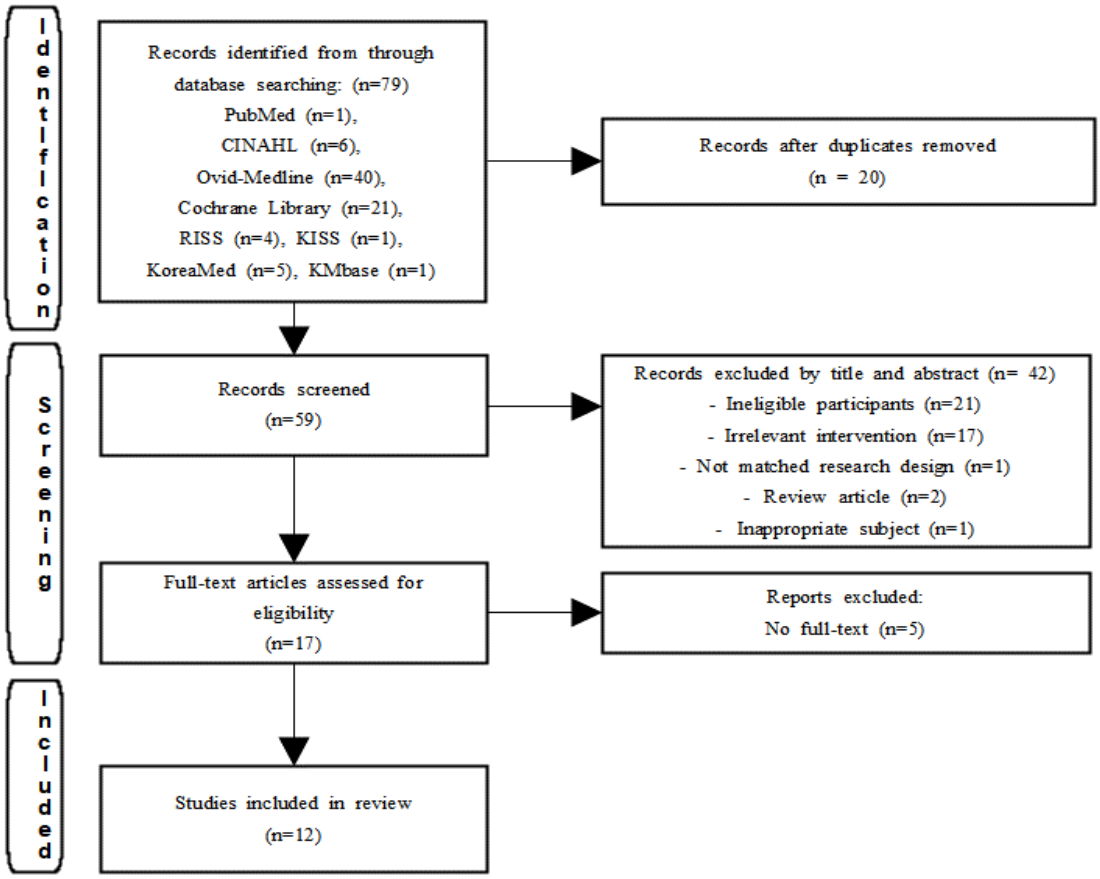


Figure 1. Flow of studies included from database search

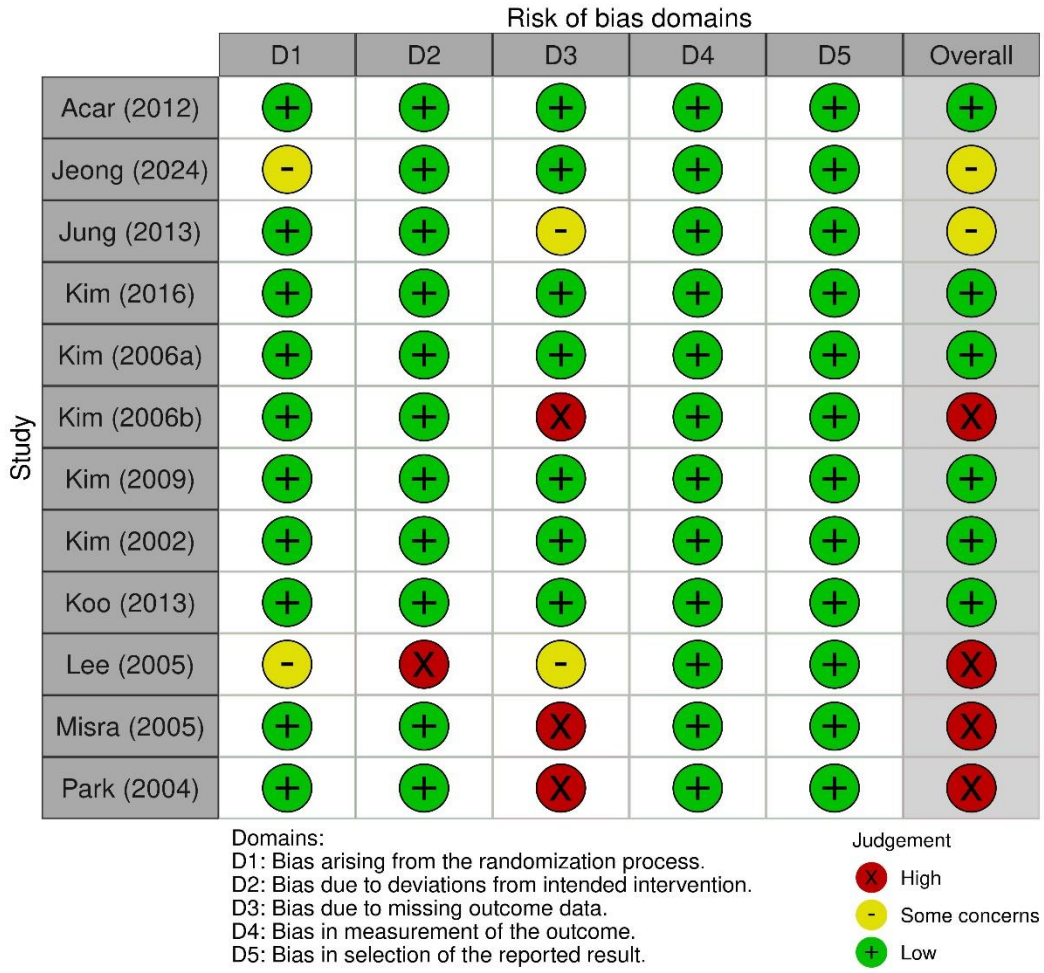
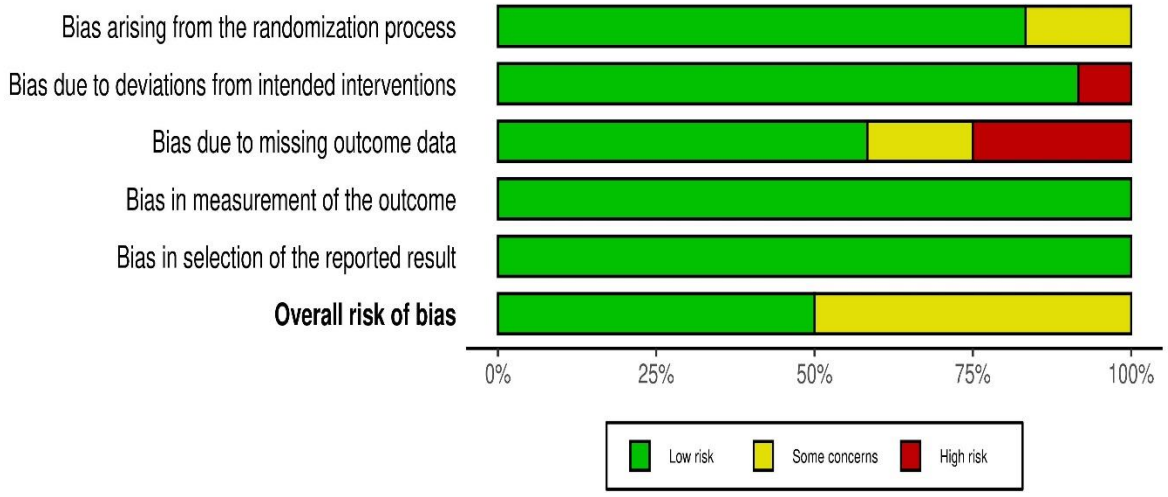


Figure 2. Risk of bias the included studies



APPENDIX. Included Studies

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