Review Article

Effectiveness of Abdominal Binders in Lowering Postoperative Pain and Distress After Cesarean Delivery: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

Iman Elzahaby[1], Ahmed Samy Ali Ashour[2] and Dalia Adel Nour[1]

Department of Obstetrics and Gynecology, [1]Faculty of Medicine, Cairo University, Egypt, [2]College of Medicine and Health Sciences, Arabian Gulf University, Bahrain

ABSTRACT

Background: Cesarean delivery (CD) is one of the most frequently performed abdominal surgeries. Nearly 50% to 70% of women experience pain following CD, making it a major concern for obstetricians. Abdominal binder (AB) is a non-pharmacological method that showed a promising effect in managing postoperative pain. However, the two recently published meta-analyses showed inconsistent results.

Objective: To assess the effectiveness of abdominal binders in reducing postoperative pain and distress in women undergoing cesarean deliveries.

Methods: Four electronic databases were comprehensively searched till June 2024 (PubMed, Scopus, Web of Science, and Cochrane Library). We only included randomized controlled trials (RCTs) that studied AB following CD. Primary outcome was postoperative pain measured with visual analog scale (VAS) or numerical rating scale(NRS). Secondary outcomes were patient distress, evaluated by symptom distress scale (SDS) and mobilization by a 6-minute walking test (6MWT). Pooled results are presented as mean differences (MDs) with corresponding 95% confidence intervals (CIs).

Results: Our meta-analysis included 10 RCTs (N=1232 patients). Abdominal binder significantly reduced post-cesarian VAS at 24h (MD= -1.13, 95% CI [-1.99, -0.27], p = 0.01) and 48h (MD= -0.62, 95% CI [-0.75, -0.49], p <0.00001). Also, it significantly lowered post-cesarian SDS scores at 24h (MD= -2.24, 95% CI [-3.26, -1.22], p <0.0001) and 48h (MD= -2.71, 95% CI [-4.63, -0.80], p =0.005). The AB group showed improved mobility than the routine care group (MD= 18.86, 95% CI [15.13, 22.59], p <0.00001).

Conclusion: Abdominal binders could be an effective non-pharmacological option in reducing postoperative pain and distress and improving mobilization after cesarean delivery.

Key Words: Binder; cesarean, distress, mobilization, pain.

Received: 18 December 2024, **Accepted:** 27 January 2025

Corresponding Author: Ahmed Samy Ali Ashour, Department of Obstetrics and Gynecology, College of Medicine and Health Sciences, Arabian Gulf University, Bahrain, **Tel.:** +97335690992, **E-mail:** ahmedsamy8233@gmail.com

ISSN: 2090-7265, 2025, Vol. 15

INTRODUCTION

Cesarean deliveries(CDs) are the most frequently performed major operation in the United States, with over 1.2 million procedures performed & 32% of all births in 2017[1]. Cesarean section (CS) rates in Egypt have increased to 52%, according to the Egypt Demographic and Health Survey (EDHS) published in 2014[2]. Egypt is ranked third in CS rates, following the Dominican Republic and Brazil, with 56.4% and 55.6% respectively[3]. The rising CD rates have a significant impact on healthcare systems, as it is linked to more significant maternal morbidity and potential complications in subsequent pregnancies[4].

Despite being a relatively straightforward and simple surgical procedure, cesarean deliveries are associated with several adverse outcomes, including pain, bleeding, infection, deep vein thrombosis, and other complications[5]. Pain is a predominant concern in postpartum recovery, with a significant proportion of women reporting moderate to severe levels following cesarean deliveries[6,7].

Inadequate acute postoperative pain management could be complicated by shallow breathing, atelectasis, chronic postoperative pain, delayed functional recovery, increased opioid use, postpartum depression retention of excretions with longer hospitalization, and reduction of quality of life[8–10]. Adequate postoperative pain management is crucial for obstetric patients to facilitate breastfeeding and provide effective care for their newborns.

Acute pain following a cesarean delivery hinders the prompt interaction between the mother and newborn, reduces the likelihood of effective breastfeeding, and

DOI:10.21608/EBWHJ.2024.345721.1404

impairs the mother's capacity to move. Additionally, it might cause anxiety and insomnia[11].

A variety of analgesic techniques, both pharmaceutical and non-pharmacological, can be employed in the postoperative phase following a cesarean section. Acetaminophen, NSAIDs, and opioids are commonly used as part of the therapeutic standard of treatment for postoperative pain after CD once the alleviation from procedural anesthesia has subsided[12].

Effective pain management following cesarean delivery using multimodal techniques, such as abdominal binders, can lower postoperative morbidity and discomfort, enhance patient outcomes, and reduce opiate use, postoperative adverse effects, and hospitalization costs[11]. Conventional pain-relieving strategies are frequently underutilized because of worries about the negative consequences on the mother and the newborn.

An abdominal binder is a wide belt composed of elastic or non-elastic material that supports the operative area after abdominal surgery[13]. Using Velcro, the soft elastic band can be stretched and secured around the abdomen to match different abdominal circumferences[14]. The device uses changing circumferential compression to alleviate wound pressure while walking and moving, thus reducing abdominal wall movements and postoperative and post-CD pain[15].

Abdominal binders are commonly used as a non-pharmacological method to improve mobility and rehabilitation, promote deep breathing, reduce wound dehiscence, and pain from coughing, laughing, or postural changes after major abdominal operations like ventral hernia repairs leading to faster resumption of normal activities and enhanced recovery after surgery[16]. Abdominal binders could help in preventing early abdominal wall complications such as tissue edema, seroma formation, psychological distress, postoperative discomfort, and wound dehiscence[17].

Additional benefits of abdominal binder compression include increased blood flow, less incision site inflammation, and faster tissue repair. It compresses the stomach and bowel to help uterine involution and its return to pre-pregnancy form[18].

Several studies have shown that abdominal binder is an effective, safe, nonpharmacologic analgesic strategy for postoperative pain and does not offer any risks or harm[5,6,11,14]. While many studies found abdominal binder effective in lowering pain and distress after CD[6,11,14,16], Chankhunaphas *et al*. found that using an abdominal binder after a cesarean birth did not make a significant difference in the pain scores or the distances covered on the 6-minute walk test (6MWT)[19]. The latest two meta-analyses[20,21], which addressed the role of abdominal binder after CD, revealed contradictory results. Abd-ElGawad *et al*.[21] meta-analysis found that abdominal binders reduced pain and distress after CD, while Di Mascio *et al*.[20] found abdominal binders ineffective in lowering pain after CD.

Given the conflicting literature, this study conducted a meta-analysis of randomized controlled trials to assess the effectiveness of abdominal binders in alleviating pain after cesarean delivery.

METHODS

In accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) Statement, we conducted this systematic review and meta-analysis[22]. "The study protocol was registered with the Open Science Framework (OSF) and can be accessed at https://doi.org/10.17605/OSF.IO/KZSV9." Due to the nature of our study design, no ethical approval was required.

Literature search

From commencement to June 2024, we conducted an extensive search of four electronic databases: PubMed, Scopus, Cochrane Library, and Web of Science, using the following search strategy: ("Cesarean Sections" OR "Cesarean Section" OR cesarean OR Caesarean OR "Abdominal Deliveries" OR "C-Section" OR "Abdominal Delivery" OR "C Section" OR "C-Sections" OR "Postcesarean Section") AND (binder OR "abdominal binding" OR "abdominal binders" OR "abdominal binder" OR truss OR trusses OR "support belt" OR "abdominal compression" OR "abdominal support" OR "corset" OR "longuette" OR "abdominal girdle" OR "bandage").

Study selection

All studies satisfying the specified PICOS criteria were included: (P) Patients: women undergoing cesarean delivery. (I) Intervention: abdominal binder (AB). (C) Comparator: Non-abdominal binder or routine care group. (O) Outcomes: The primary outcome was postoperative pain assessed by a visual analog scale (VAS) or numerical rating scale (NRS). Secondary outcomes were patient distress, assessed by symptom distress scale (SDS) and mobilization by a 6-minute walking test (6MWT). (S) Study design: Randomized controlled trial (RCTs). We excluded interventions other than abdominal binders, surgeries other than cesarean delivery, non-randomized study designs, non-human trials, abstracts, non-English studies, articles without full text, and non-published trials.

Two independent reviewers performed the screening process. Initial screening involved reviewing the titles and abstracts of all obtained citations, followed by screening

the whole text for eligibility. Furthermore, eligible studies' reference lists were examined for relevant articles. Any conflicts or debates were solved by discussion with a third senior reviewer.

Quality assessment

The Cochrane Risk of Bias tool 2 (ROB 2) was employed to evaluate the quality of the studies included in our analysis[23]. It includes five main domains: randomization process, deviation from the intended interventions, missing outcome data, measurement of outcome, and selection of the reported result. Each study was rated as low risk, some concern, or a high risk of bias. In addition, We assessed the evidence quality of all outcomes by applying the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) guidelines[24]. It depends on five main domains to judge each outcome as high, moderate, low, and very low quality:

1. Risk of bias,
2. Inconsistency,
3. Indirectness,
4. Imprecision,
5. Publication bias.

Data extraction

The subsequent data were extracted: 1. Summary and baseline characteristics of included studies such as the study ID, study design, country, inclusion and exclusion criteria, used analgesics, study group, sample size, type of abdominal binders, and duration of abdominal binders' application. Moreover, patients' age, body mass index, parity, gravidity, previous CD, previous vaginal delivery, and gestational age; 2. Efficacy outcomes include pain scores 24 and 48 hours postoperatively evaluated using visual analog scale (VAS), which is a 10 cm long scale, where 0 represents no pain at all, and 10 means the worst pain[25]; distress scores at 24, and 48 hours after the surgery assessed by the symptom distress scale (SDS) which is a 13-item survey with a score ranging from 13 to 65, where high scores indicate higher distress level[26]; and 6-minute walk test (6MWT) which is an objective test used to assess mobility[27]. The necessary data was extracted independently by two reviewers, and any points of disagreement were resolved through discussion.

Data analysis

Data analysis was conducted using Review Manager Software 5.4. Continuous data was extracted and combined to calculate the mean difference (MD) with a 95% confidence interval (CI) using the inverse variance method. Random effect model was used only with heterogeneous results; otherwise, a fixed effect model was used. Significant statistical heterogeneity was defined as a chi-square *p-value* < 0.1 and an I-square statistic (I2) > 50%[28]. Sensitivity analysis was performed to solve the existing heterogeneity, if possible. Publication bias could not be assessed according to Egger *et al*.[29], which requires a minimum of 10 pooled studies to make it reliable.

RESULTS

Search results and study selection

The literature search yielded 2932 citations after duplicate removal. Another 2906 citations were removed after title and abstract screening, and only 26 citations proceeded to full-text screening. Finally, 10 RCTs[5,6,11,14,19,30-34] were included in our review (Figure 1).

We included 10 RCTs compromising 1232 patients (abdominal binder (n = 625) and non-abdominal binder (n = 607)). Three trials were conducted in the USA[11,14,32], two in Thailand[5,19], another two were conducted in Iran[6,34], and the last three were conducted in Indonesia[33], Egypt[31], and Turkey[30]. In general, AB was found to reduce postoperative pain, and distress, and improve mobility in all the trials except Surya *et al*.[33], Chankhunaphas *et al*.[19], and Gillier *et al*.[14], which found no significant difference between both groups.

Inclusion and exclusion criteria were nearly consistent among all trials. Generally, they included women undergoing elective or planned cesarian delivery with no pregnancy complications. (Table 1). Patients in control group were offered the standard routine care with no chance to wear AB. In comparison, patients in the intervention group were offered an elastic AB immediately or within two hours after delivery. They were asked to wear AB all the time. However, they could take breaks from wearing them whenever it was convenient. Both groups were allowed to take analgesics when necessary. A summary of the analgesics used, and the AB application method are summarized in (Tables 1,2).

Table 1: Summary of included studies.

ID	Study Design	Sample size	Country	Inclusion criteria	Exclusion criteria	Analgesic use
Surya et al. 2023	RCT	60	Indonesia	Women with singleton term pregnancy undergoing cesarean section aged 15-40 years, body mass index (BMI) lower than 40 kg/m2, read and understand the Indonesian language	patients with a history of cesarean section, second stage dystocia, abnormal placenta (placenta previa or placenta accrete), hemoglobin level preoperative less than 10 g/dL, chorioamnionitis (intrauterine-infection), cesarean hysterectomy due to severe hemorrhage, organ injury (cystotomy, enterotomy, or ureteral injury), and outside spinal anesthesia during cesarean section	Participants in both groups received pain medication consisted of ketorolac injection 30 mg/ 8 hour in the first 24 hours and whether they still complained of pain, another analgesic such as paracetamol injection 1g/8 hour was given; 3 (10.0%)
Singhdaeng et al. 2020	RCT	50	Thailand	women ≥18 years, had undergone elective low transverse cesarean delivery under spinal anesthesia combined with intrathecal morphine	body mass index (BMI) > 35 kg/m², any postoperative drainage, walking disability, chronic cough, peri-operative organ injury, or post-cesarean hysterectomy	NA
Chankhunaphas et al. 2019	RCT	179	Thailand	pregnant women, age 18–45 years, who underwent caesarean delivery	Comprised intraoperative accidental injury to urinary or gastrointestinal organs, cesarean hysterectomy, post-operative admission to intensive care unit, postoperative intraperitoneal drain placement, severe neuromuscular or circulatory disorders, pulmonary diseases	NA
Hassan et al. 2021	RCT	98	Egypt	Elective CS delivery at term, singleton viable fetus, aged 18 - 34 years old, parity not more than 2, were able to read and write. CS cases that are not combined with hysterectomy or other surgical operations. Free from medical disease and chronic pain in the past year	Bleeding disorders or use of anticoagulants; abnormal placenta (previa or accreta). use of methadone; preoperative hemoglobin level less than 10mg/dL. Chorioamnionitis. General anesthesia	Binder group Need for analgesia: - Need but not met: 14 (28.6%) - Need and met :1 (2.00%) - No need :34 (69.4%) Control group Need for analgesia: - Need but not met: 40 (81.7%) - Need and met: 5 (10.2%) - No need: 4 (8.1%)
Gillier et al. 2016	RCT	155	USA	Women aged 18-50 years who underwent cesarean delivery by a low transverse skin incision	General anesthesia, vertical skin incision, and placement of any postoperative drain.	Ibuprofen (mg) POD 1 (B) 520 ± 551 (C) 606 ± 520 0.25 POD 2 (B) 1150 ± 590 (C) 810 ± 530 0.19b Acetaminophen (mg) POD 1 (B) 924 ± 193 (C) 1010 ± 320 0.21 POD 2 (B) 1300 ± 250 (C) 1248 ± 360 0.89 Morphine (U) POD 1 (B) 21.1 ± 20.1 (C) 23.8 ± 23.2 0.57 POD 2 (B) 28.4 ± 22.1 (C) 28.1 ± 21.2 0.92 Ketorolac (mg) POD 1 (B) 41 ± 33 (C) 24 ± 38
Ghana et al. 2017	RCT	178	Iran	Patients had to have a parity of 1 or 2 during the index pregnancy, literate, uncomplicated term singleton pregnancy, to have undergone Pfannenstiel incision on the skin and Kerr incision on the uterus at the site of a previous cesarean delivery (if any), to have a body mass index of 18.5- 25.9, and to have a hemoglobin level of >110 mg/L during the first trimester.	Unable to tolerate the binder, were not willing to participate, were currently smokers or using opioids, had experienced rupture of membranes for longer than 6 h, had any self-reported underlying disease, had a surgical duration longer than 1 h, had undergone classic incision of the uterus, had undergone any concurrent surgeries (such as hysterectomy, myomectomy, or tubal ligation), had pre-eclampsia or eclampsia, had severe hemorrhage or hemorrhage leading to hysterectomy, had bleeding disorders or were using anticoagulants (such as heparin or warfarin), had experienced damage to body tissues during cesarean delivery, had undergone an emergency cesarean delivery, or had received general anesthesia.	Both patient groups received routine care and medications (serum therapy and analgesia if required), and VAS measurements were scheduled to be taken 15 min before any routine administration of analgesia

Continue Table 1

Karaca et al. 2019	RCT	89	Turkey	Women who underwent elective CS.	women with more than two previous pregnancies, not delivering the current pregnancy at term, with an emergency cesarean, who underwent general anesthesia instead of spinal anesthesia, with chronic diseases, and who underwent non-routine or additional surgical procedures, such as hysterectomy, tubal ligation, and classical uterine incision.	Additional non-steroidal analgesia, if necessary
Tussey et al. 2019	RCT	84	USA	Inclusion criteria included English- or Spanish-speaking patients aged ≥18 years.	Women with a postoperative drain, vertical incision, respiratory distress, chronic pain (defined as those patients on chronic opioid medications), or medical orders against ambulation were excluded	Ibuprofen (mg) POD 1 (B) 92 ± 258 (C) 71 ± 196 POD 2 (B) 1763 ± 648 (C) 1553 ± 663 Acetaminophen (mg) POD 1 (B) 427 ± 537 (C) 325 ± 512 POD 2 (B) 2045 ± 1157 (C) 1501 ± 1028 Morphine (U) POD 1 (B) 13 ± 17 (C) 8 ± 13 POD 2 (B) 48 ± 27 (C) 30 ± 24 Ketorolac (mg) POD 1 (B) 105 ± 26 (C) 101 ± 31 POD 2 (B) 5 ± 19 (C) 4 ± 10
Hoskins et al. 2022	RCT	159	USA	Inclusion criteria for study enrollment included individuals birthing via cesarean who were deemed medically stable and able to understand the research consent information provided in English or Spanish	Individuals were excluded from eligibility if they were admitted to the Mom–Baby Unit more than 4 hours after birth received general anesthesia for cesarean birth had a vertical incision, had a body mass index greater than 45 kg/m2, were younger than 18 years, required opioids other than oxycodone (because of allergy to oxycodone or medication-assisted therapy), or received intravenous opioids within the hour before consent.	the total use of oxycodone (in milligrams) was lower in the binder group (12.2 mg) compared with the control group (15.9 mg)
Anvari et al. 2024	RCT	180	Iran	The inclusion criteria include not having any underlying disease (neuro-muscular disorders, high blood pressure, kidney disease, heart disease), spinal anesthesia, not using anti-anxiety, soporific and sedative drugs, first and second caesarean section, Body mass index was between 18.5 and 29.9, hemoglobin was higher than 10, term neonate, singleton pregnancy, pregnancy without complications such as the absence of eclampsia and preeclampsia, Pfannenstiel incision on the skin and Kerr incision on the uterus	Exclusion criteria include uterine atony, the patient's intolerance to the abdominal binder, unwillingness to continue participating in the study, the need to perform simultaneous surgery such as hysterectomy, severe bleeding after surgery, damage to body tissues during cesarean surgery such as damage to the urinary tract and the digestive tube.	In both groups, suppositories (diclofenac sodium 100 mg) and injectable sedative pethidine and acetaminophen were used within 24 hours after cesarean section if needed

Abbreviations: BMI, Body mass index; CD, Cesarean delivery; COPD, Chronic obstructive pulmonary disease; Hb, Hemoglobin; IV, Intravenous; POD, Postoperative day; RCT, Randomized controlled trial; NA, Not available.

Table 2. Baseline characteristics of study population.

ID	Study groups	Number	Application of the abdominal binder	Age, M ±SD	BMI (kg/m2), M ±SD	Gravidity, M ±SD	Parity, M ±SD	Previous CD, N (%)	Gestational age (wks)
Surya et al. 2023	Binder	30	Immediately postoperative for minimally 24 hours after the surgery	30.7 ±6.8	23.15 ±3.48	NA	NA	0 (0)	39 ±1.22
	Control	30		33.1 ±7.7	24.22 ±3.84	NA	NA	0 (0)	39 ±0.98
Singhdaeng et al. 2020	Binder	25	At 2 hours post-operation. Women wore it for 2 days after the operation and were checked every 4 hours by a standardized training nurse at the postpartum ward and was taken off between 10 PM. and 8 AM.	27.16 ±4.92	25.13 ±3.87	NA	NA	18 (72)	NA
	Control	25		28.68 ±4.44	22.06 ±3.57	NA	NA	14 (56)	NA
Chankhunaphas et al. 2019	Binder	89	At the time of procedure completion just before leaving the operating room. Patients were encouraged to wear binders at all times.	31.9 ±5.3	28.0 ±4.1	2.2 ±1.1	NR	NA	37.9 ±2.6
	Control	90		31.7 ±4.8	27.9 ±4.5	2.0 ±1.0	NR	NA	38.3 ±2.0
Hassan et al. 2021	Binder	49	The women were encouraged to apply the binder day and night in the first 7 days postpartum, she can remove it only while taking a shower. The mothers in the binder group were fitted with the device that was placed low on the abdomen across the incision before leaving the operating room. After the mother was transferred to the inpatient unit, they were instructed to continue wearing the binder for the first 48 hours postoperatively	29.9 ±3.2	NA	NA	1.85 ±0.6	49 (100)	38.6 ±0.6
	Control	49		29.2 ±3.6	NA	NA	1.8 ±0.8	49 (100)	38.5 ±0.9
Gillier et al. 2016	Binder	87	Abdominal binder applied immediately after delivery and used for 2 days with unmeasured breaks allowed. Patients were encouraged to wear the abdominal binder throughout the day and night; however, they were allowed unmeasured breaks from wearing the device.	30.1 ±5.0	34.0 ±7.3	2.6 ±1.8	0.9 ±0.8	0.7 ±0.7	38.8 ±1.7
	Control	68		28.0 ±6.9	32.5 ±7.4	2.6 ±1.6	0.8 ±0.9	0.7 ±0.8	38.5 ±2.2
Ghana et al. 2017	Binder	89	Abdominal binder applied 2 hours after delivery and used for 2 days. Binder was opened between 10pm and 8am	NA	22.6 ±2.3	NA	NA	89 (100)	NA
	Control	89			23.3 ±2.4	NA	NA	89 (100)	NA
Karaca et al. 2019	Binder	45	After completing the CS, the abdominal binder was fitted to the lower abdomen by covering the incision.	27.1 ±6.0	33.1 ±1.5	2.1 ±1.3	0.9 ±0.8	NA	38.6 ±1.7
	Control	44		26.3 ±6.9	32.7 ±1.8	2.3 ±1.7	0.8 ±0.7	NA	38.4 ±1.5

Continue Table 2

Tussey et al. 2019	Binder	49	It was applied by a nurse the first time patients were ambulated. The nurse provided patient education on the proper use of the binder and applied the binder using the manufacturer's recommendations and the woman's comfort level. The binder was worn during the entire time of ambulation. Patients were instructed to wear the binder as much as possible; if they chose to loosen the binder for comfort while at rest, it was reapplied before the next ambulation	31.51 ±6.11	35 ±6.8	NA	40 (81.6)	36 (58.3)	38.79 ±1.10
	Control	35		30.46 ±7.14	34.6 ±6.8	NA	27 (77.1)	25 (71.4)	38.60 ±1.02
Hoskins et al. 2022	Binder	72	The abdominal binder was placed around their torso before their first ambulation after surgery (typically 6–8 hours after surgery). Participants in this group were encouraged to wear the binder as much as possible during the first 48 hours after surgery.	32.68 ±4.97	NA	NA	NA	42 (41.6)	38.9 ±1.33
	Control	87		32.72 ±5.12	NA	NA	NA	60 (58.4)	38.9 ±1.32
Anvari et al. 2024	Binder	90	The abdominal binder was tied to the patient before leaving the operating room. the appropriate abdominal binder (size Medium, Large) was closed for 24 hours after the operation. For the comfort of the patient, the abdominal binder was opened between 00:00 AM and 6:00 AM	28.58 ±7.01	25.43 ±2.59	2.37 ±1.05	NA	60 (66.67)	NA
	Control	90		27.7 ±7.23	25.3 ±2.55	2.37 ±1.1	NA	63 (70)	NA

Abbreviations: BMI, Body mass index; NA, Not available; M, Mean; SD, Standard deviation; CD, Cesarean delivery; WKS, Weeks.

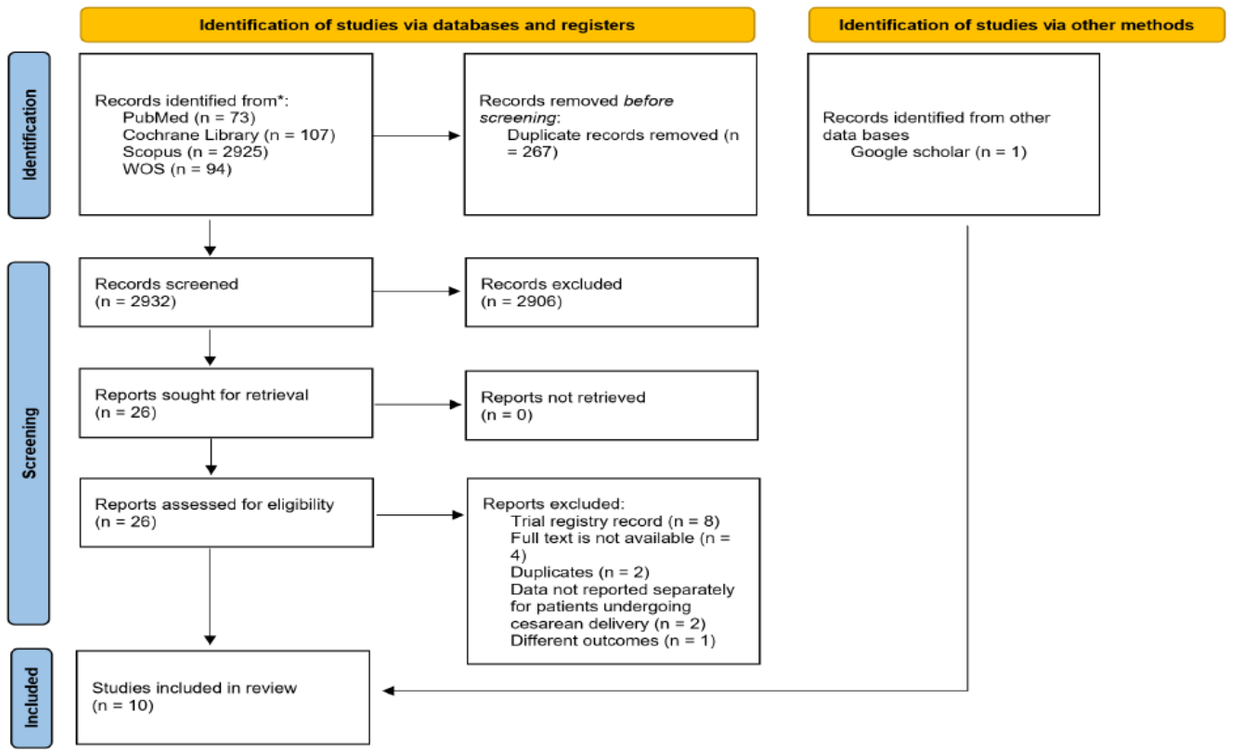

Fig. 1: PRISMA flow diagram and chart

Quality assessment

All studies showed an overall high risk of bias due to lack of blinding except Anvari *et al*.[34], which had an overall low risk of bias. Also, they showed a low risk of bias in all domains except Hassan *et al*.[31], which had some concerns regarding the randomization process and concealment, and Hoskins *et al*.[31], which showed a high risk of missing outcome data. (Figures 2,3). The quality of evidence assessed by the GRADE approach is illustrated in (Table 3).

Table 3: The quality of evidence assessed by the GRADE approach

Certainty assessment							No of patients		MD, 95% CI	Certainty
No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Abdominal binder	Control		
Pain score at 24 hours after surgery										
9	RCT	Serious[a]	Serious[b]	Not serious	Not serious	None	553	520	-1.13 (-1.99, -0.27)	⊕⊕◯◯ Low
Pain score at 48 hours after surgery										
7	RCT	Serious[a]	Serious[b]	Not serious	Not serious	None	456	452	-0.62 (-0.75, -0.49)	⊕⊕◯◯ Low
Distress score at 24 hours after surgery										
6	RCT	Serious[a]	Serious[b]	Not serious	Serious[c]	None	349	315	-2.24 (-3.26, -1.22)	⊕◯◯◯ Very low
Distress score at 48 hours after surgery										
5	RCT	Serious[a]	Serious[b]	Not serious	Serious[c]	None	319	285	-2.71 (-4.63, -0.80)	⊕◯◯◯ Very low
6MWT										
4	RCT	Serious[a]	Not serious[c]	Not serious	Serious[d]	None	163	164	20.22 (16.25, 24.19)	⊕⊕◯◯ Low

RCT; Randomized controlled trial, MD; Mean difference, CI; Confidence interval, 6MWT; 6-minute walk test.

[a] Studies showed a high risk of bias. [b] Results showed high heterogeneity. [c] Wide confidence interval.

[d] The analysis included a small number of patients with wide confidence interval. [e] There was some heterogeneity that was resolved by leaving-one-out test.

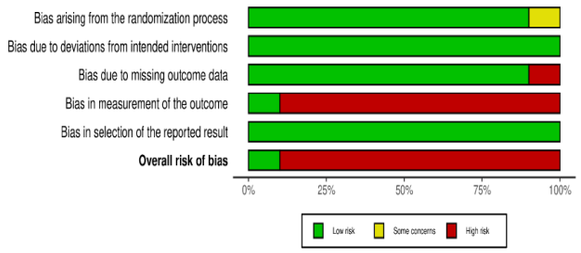

Fig. 2: Risk of bias summary of included studies

Fig. 3: Risk of bias graph of included studies

Pain score at 24 hours after surgery

All included trials except Hoskins *et al.*[32] measured pain by VAS score 24 hours post-CD (553 in binder group and 520 in control group). Pooled analysis showed that abdominal binder group had a significantly lower mean VAS score than control group (MD= -1.13, 95% CI [-1.99, -0.27], p = 0.01; Low-quality evidence). However, the result was heterogenous (p <0.00001, I2 = 98%).], p= 0.01; Low-quality evidence). However, the result was heterogenous (p<0.00001, I2 = 98%). A leave-one-out test could not resolve this heterogeneity (Figure 4A).

Pain score at 48 hours after surgery

Pain at 48 hours post-CD was reported in seven trials[5,6,14,19,30–32] (abdominal binder (n=456) and control group (n=452)). Pooled results showed that abdominal binders reduced the mean VAS score more than the standard routine care. The result was significant but heterogeneous that could not be resolved by leave-one-out test (MD= -0.62, 95% CI [-0.75, -0.49], p <0.00001; Low-quality evidence), (p <0.00001, I2 = 95%) (Figure 4B).

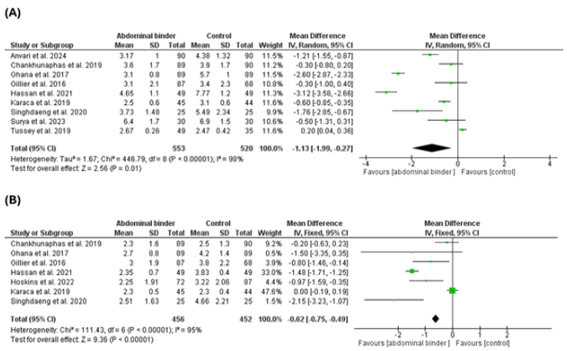

Fig. 4: Forest plots showing mean difference (SMD) for postoperative VAS score at 24 h [A], and 48 h [B] between abdominal binder and control groups

Distress score at 24 hours after surgery

Meta-analysis of six Trials[6,11,14,30,31,33] (349 in binder group and 315 in control group) showed a significantly reduced level of distress in binder group more than control group (MD= -2.24, 95% CI [-3.26, -1.22], p<0.0001; Very low-quality evidence). Pooled result was significantly heterogeneous, which could not be resolved by sensitivity analysis (p <0.0001, I2 = 82%) (Figure 5A).

Distress score at 48 hours after surgery

Distress score 48 hours after surgery was reported in five trials[6,11,14,30,31] involving 319 in abdominal binder group and 285 in control group. Pooled analysis showed a significant reduction in SDS score in binder group more than control group (MD= -2.71, 95% CI [-4.63, -0.80], p=0.005; Very low-quality evidence). Pooled results showed a high heterogeneity which could not be resolved by sensitivity analysis (p <0.00001, I2 = 96%) (Figure 5B).

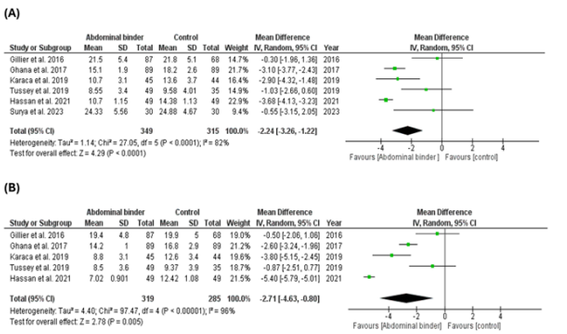

Fig. 5: Forest plots showing mean difference (SMD) for postoperative SDS score at 24 h [A], and 48 h [B] between abdominal binder and control groups

Six-minute walking test

Only four trials[19,30,31,33] assessed mobility by 6MWT (208 in binder group and 208 in control group). Pooled results showed that abdominal binder had significantly improved mobility more than the usual routine (MD= 18.86, 95% CI [15.13, 22.59], p <0.00001; Low-quality evidence). However, the results showed some heterogeneity (p =0.16, I2 = 43%) (Figure 6A). This was resolved by excluding Karaca *et al*.[30] (p =0.5, I2 = 0%) (Figure 6B).

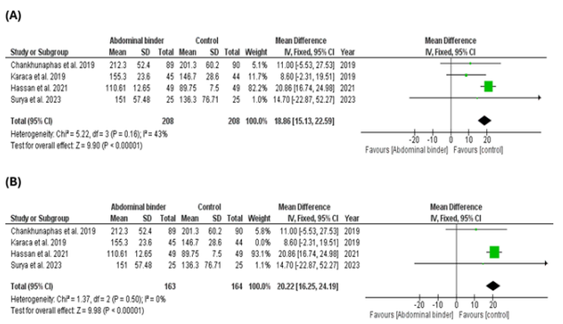

Fig. 6: Forest plots showing mean difference (SMD) for postoperative 6MWT [A], and 6MWT after exclusion of Karaca *et al*. [B] between abdominal binder and control groups

DISCUSSION

In women who have had a cesarean delivery, abdominal binders can serve as a cost-effective and non-pharmacologic adjunct to pain treatment. Effective pain management using multimodal approaches is essential for ensuring the safe completion of daily activities and early ambulation, therefore decreasing the risk of thromboembolism[35]. Opioids used alone for pain treatment after obstetric procedures are associated with higher costs, risks of dependence, complications, and duration of hospitalization in comparison to multimodal therapies[36]. So, non-pharmacologic therapy is ideal for this population due to breastfeeding, early postoperative mobilization, and maternal attentiveness.

Our study included 10 RCTs addressing the pain and distress-lowering effect of abdominal binders after CD. Our meta-analysis demonstrated that abdominal binder significantly lowered pain 24 and 48 hours after CD. Additionally, patients distress 24 and 48 hours post-CD was significantly lower in binder group than in control group. Moreover, abdominal binder improved mobility by increasing the six-minute walking distance in comparison to control group. All pooled outcomes had significant heterogeneity. The aggregated findings exhibited significant heterogeneity, initially attributed to the studies' varying surgical techniques, analgesic usage, adherence, or geographical locations.

The findings of our study confirmed the advantages of using an abdominal binder in cesarean delivery, indicating that it can be widely applied. Furthermore, the binder's beneficial benefits persisted even during postoperative analgesic application, indicating that it has extra effects independent of analgesic medicine.While we statistically determined abdominal binder clinical values, pooled estimates had limited MDs and ranges, potentially limiting these values. Future investigations may be needed.

Di Mascio *et al*.[20] Assessed the effectiveness of abdominal binders in lowering postoperative pain, patient distress, and surgical postoperative complications following CD. Four RCTs (601 women) were included. They reported no significant difference between the two groups regarding VAS scores at both 24 hours and 48 hours. However, the abdominal binder was successful in lowering postoperative distress both at 24 h and 48 h. On the other side, Abd-ElGawad *et al*.[21] meta-analyzed six RCTs and found that abdominal binders significantly reduced postoperative pain and distress scores 24 and 48 hours after CD.

From a broader point of view, Sun *et al*.[37] evaluated the efficacy of abdominal binders (ABs) in reducing postoperative pain and improving functional recovery in individuals undergoing abdominal surgery. There were significant differences in VAS pain scores and physical function between abdominal binder and control groups. So, abdominal binder could enhance postoperative pain relief and physical function, particularly on the fourth day or later after abdominal surgery.

Evidence on postoperative abdominal binding was sought in a meta-analysis study by Ossola *et al*.[38]. They concluded that wearing an abdominal binder after a midline laparotomy reduces postoperative pain on the first and third day after surgery, enhances physical activity on the third day after surgery, and has no impact on pulmonary functioning. Typically, a flexible abdominal binder is easily tolerated during the postoperative period.

A meta-analysis by Jiang *et al*.[39] confirmed that using an abdominal binder effectively enhances recovery following abdominal surgeries by improving mobilization, relieving pain, and minimizing postoperative discomfort. The study found that using an abdominal binder substantially increased the distance covered during the 6-minute walk test (6MWT) and decreased scores on VAS and SDS. Nevertheless, their research was constrained by substantial heterogeneity and publication bias.

Abdominal binders also had a significant effect in lowering postoperative psychological distress after open abdominal surgery. However, their impact on seroma formation after ventral hernia repair and postoperative pain following laparotomy remains uncertain[40]. The abdominal

binder proved effective in gynecological operations. In Chantawong & Charoenkwan's study[41], they investigated the impact of elastic abdominal binder on recovery and postoperative pain of patients with gynecologic cancer. They conclude that abdominal binder may reduce postoperative pain and improve functional recovery after open gynecologic cancer surgery for cervical, endometrial, or ovarian cancer, but only for people aged ≥ 50.

In Yang & Song's[42] study, the impact of an abdominal binder on the recovery process following laparoscopic surgery in patients with gynecologic disease was evaluated. They concluded that abdominal binder did not improve postoperative recovery regarding pain, respiratory function, or physical activity. Another similar study by[43] reported a similar conclusion that utilization of an abdominal binder did not yield any advantageous outcomes for alleviating postoperative shoulder pain subsequent to laparoscopic gynecologic surgery. Additionally, the abdominal binder failed to improve surgical site pain, ambulation time, and postoperative nausea and vomiting.

In our included studies, there was not enough data about safety outcomes to be pooled in a meta-analysis. However, there were few adverse effects reported in the individual studies included. One Surya *et al*. study participant reported that the abdominal binder was too tight. Itching was found in 3 women in binder group in Singhdaeng *et al*. study. Negative feedback for abdominal binder was reported by 2% of participants in binder group in Hoskins *et al*. study, as they described the binder as tight and itchy. No side effects for abdominal binders were reported in Gillier *et al*. study.

Strengths and limitations

Our meta-analysis has several strengths, such as our inclusion of RCTs, which is considered the hallmark of evidence-based practice. Moreover, the trials included were conducted in a variety of study locations. The PRISMA criteria and checklist were also adhered to, and all procedures were executed precisely following the Cochrane Handbook of Systematic Reviews for Interventions. However, our study was limited by the small number of included studies and small sample size. The results were evaluated using only three key outcomes, and non-English research was eliminated. However, new evidence demonstrates that this does not prejudice the meta-analysis. Studies were heterogeneous (different surgical procedures, outcomes, analgesic treatment, etc.). Therefore, thorough clinical trials with high sample sizes are recommended to evaluate the clinical benefit of an abdominal binder.

Conclusion

Use of an abdominal binder provides advantages to patients who have undergone cesarean delivery by promoting early mobilization, relieving pain, and minimizing postoperative distress.

There is limited evidence that using abdominal binders after cesarean delivery improves pain, physical function, and psychological distress.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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