

■ Review

Enhanced Recovery After Surgery Programs in Cesarean Delivery: Review of the Literature

Sezaryen Doğumda Gelişmiş Cerrahi Sonrası İyileşme Programları: Literatür Taraması

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Abstract

Enhanced Recovery After Surgery (ERAS) programs have been improved surgical outcomes in many surgical sub-specialties, since the early 2000s. This multidisciplinary standardized care program aimed to optimize preoperative, intraoperative, and postoperative care of patients undergoing surgery. Recent reports showed that the ERAS protocols have been successfully implemented in cesarean deliveries. The key elements of ERAS program in cesarean delivery are antenatal education/counseling, preoperative medical optimization, preanesthetic medication, limited fasting time, carbohydrate supplementation, intraoperative anesthetic management, surgical site infection prophylaxis, maintenance of normothermia and euvoemia, appropriate surgical technique, newborn care, postoperative analgesia, prevention of nausea and vomiting, early feeding, early mobilization, thromboembolism prophylaxis, glucose management, urinary management, and discharge counseling. The implementation of these elements resulted with improved maternal/neonatal outcomes and reduced length of hospital stay. However, the current literature on this topic is not enough to develop a standardized globally implemented ERAS protocol for cesarean delivery. Further studies are required to enhance the care program and recommendations.

Keywords: Cesarean delivery; enhanced recovery after surgery; intraoperative; preoperative; postoperative

Öz

Gelişmiş Cerrahi Sonrası İyileşme (ERAS) programları, 2000'li yılların başından beri birçok cerrahi uzmanlık dalında operasyon sonuçlarını iyileştirmiştir. Bu multidisipliner standart bakım programı, cerrahi hastalarının preoperatif, intraoperatif, postoperatif bakımını optimize etmeyi amaçlamıştır. Yeni yayınlar ERAS protokollerinin sezaryen doğumlarda başarıyla uygulandığını göstermiştir. Sezaryen doğumda ERAS programının temel öğeleri; antenatal eğitim/danışmanlık, cerrahi öncesi tıbbi optimizasyon, anestezi öncesi medikasyon, sınırlı açlık süresi, karbonhidrat suplementasyonu, intraoperatif anestezi yönetimi, cerrahi alan enfeksiyon profilaksisi, normotermi ve övoleminin sürdürülmesi, uygun cerrahi teknik, yenidoğan bakımı, postoperatif analjezi, bulantı ve kusmanın önlenmesi, erken beslenme, erken mobilizasyon, tromboembolizm profilaksisi, glukoz yönetimi, idrar yönetimi ve taburculuk danışmanlığıdır. Bu öğelerin uygulanması, maternal /neonatal sonuçların iyileşmesi ve hastanede kalış süresinin azalması ile sonuçlanmıştır. Bununla birlikte, bu konudaki mevcut literatür sezaryen doğum için standartlaştırılmış, küresel olarak uygulanan bir ERAS protokolü geliştirmek için yeterli değildir. Bakım programını ve önerileri geliştirmek için daha fazla çalışmaya ihtiyaç vardır.

Anahtar Kelimeler: Sezaryen doğum; gelişmiş cerrahi sonrası iyileşme; intraoperative; preoperatif; postoperatif

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1. Introduction

Enhanced Recovery After Surgery (ERAS) is a multidisciplinary standardized perioperative care program aimed to improve clinical care in surgical patients from perioperative planning to postoperative period. ERAS program optimize the patient care to decrease the stressor effect of surgery and accelerate the return of normal physiological function. ERAS protocols include preoperative, intraoperative and postoperative care. The key element of this pathway is preoperative patient education, limiting fasting time, intraoperative maintenance of normothermia, optimizing fluid intake, standardizing analgesia, postoperative early feeding, early ambulation and early hospital discharge.

Since 2001, the ERAS protocols were developed for many surgical sub-specialties such as colorectal, hepatobiliary, urologic and gynecologic surgery. Clinical benefits of ERAS such as reduction of complications, length of hospital stay, readmission to the hospital and cost-effectiveness has been shown in various surgical disciplines (1). Recently published papers indicate that the ERAS programs implemented in cesarean deliveries could reduce maternal morbidity and mortality in addition to these clinical and health system benefits (2). For these purposes Enhanced Recovery After Surgery Society guidelines for cesarean delivery were released in 2018 and 2019 (3-5). A pathway process from 30-60 minutes before skin incision to hospital discharge was reported in these three guidelines. At the same time, the Society for Obstetric Anesthesia and Perinatology (SOAP) reported a consensus document regarding this issue (6).

ERAS program for cesarean delivery consists of antenatal-preoperative, intraoperative, and postoperative care of women undergoing cesarean section. The major expected benefits of this program are to speed recovery of bowel function, maintain breastmilk supply, decrease postoperative pain, reduce complication rates, increase women satisfaction, and get moms ready for home. The elements of ERAS program in cesarean delivery were reviewed in this paper.

2. Antenatal-Preoperative Care

General ERAS program in the antenatal-preoperative period includes antenatal education/counseling, preoperative medical optimization, preanesthetic medication, preoperative bowel preparation, limited fasting time, and carbohydrate supplementation (Table 1).

a. Antenatal education and counseling

Comprehensive antenatal education and counseling was strongly recommended by ERAS Society, although the evidence level was very low (3). Antenatal counseling should include the scheduled/unscheduled cesarean delivery need, indications of cesarean delivery, the type of procedure, the recommended type of anesthesia, and possible complications. If a need of neonatal care of newborn in an intensive care unit is identified, the pregnant women should be informed by a neonatologist or pediatrician preoperatively. Women who will undergo cesarean delivery without a medical indication should be informed preoperatively about the short-term complications such as intra-abdominal organ injury, postoperative pain, infection, venous thromboembolism and long-term complications (risk of uterine rupture, severe hemorrhage, and placental insertion anomalies in subsequent pregnancy). Short-term (respiratory morbidity, neonatal intensive care unit admission, longer hospital stay) and long-term (inflammatory bowel disease, childhood onset type I diabetes mellitus, obesity, asthma) outcomes of infant and childhood should also be discussed with parents (3). Education about the breastfeeding in antenatal period is also recommended by SOAP (6).

b. Preoperative medical optimization

Antenatal medical optimization is required for good surgical outcomes. Body mass index, preexisting hypertension, diabetes mellitus and anemia are the modifiable clinical factors preoperatively.

Maternal obesity significantly increases the adverse maternal and fetal outcomes. It was shown that the risk of gestational diabetes mellitus, preeclampsia, surgical site infection, cesarean delivery, preterm birth, perinatal death, fetal macrosomia, and congenital anomaly was increased in obese women (7). Surgical technique and anesthetic management are also more difficult in obese women. Wound hematoma/abscess/dehiscence, anesthesia related complications, difficult intubation, and maternal death are more frequent in this population (8-9). Optimal gestational weight gain management during antenatal period is important to improve surgical outcomes. Based on Institute of Medicine Gestational Weight Gain Guideline, underweight women (Body Mass Index (BMI) < 18.5 kg/m²), normal weight women (BMI 18.5–24.9 kg/m²), overweight women (BMI 25.0–29.9 kg/m²), and obese women (BMI ≥ 30.0 kg/m²) should gain 12.5-18 kg, 11.5-16 kg, 7-11.5 kg, and 5-9 kg during pregnancy, respectively (10).

Tablo 1. Elements of Enhanced Recovery After Surgery program in cesarean delivery	
ANTENATAL-PREOPERATIVE CARE	
Antenatal education and counseling	Antenatal education and counseling should include scheduled/unscheduled cesarean delivery need, indications of cesarean delivery, the type of procedure, the recommended type of anesthesia, possible short-term and long-term complications that may occur in mother and baby, and breastfeeding.
Preoperative medical optimization	Maternal obesity, preexisting hypertension, diabetes mellitus and anemia should be managed appropriately to improve the maternal and neonatal outcomes in the preoperative period. Smoking cessation before pregnancy or in early gestational weeks should be recommended.
Preanesthetic medication	Preoperative antacid and H2 receptor antagonists should be used to reduce the risk of aspiration pneumonia. Preoperative sedation is not recommended because of adverse maternal and neonatal outcomes.
Preoperative bowel preparation	Preoperative bowel preparation (oral/mechanical) should not be carried out.
Preoperative fasting	The clear fluids and solid foods should be prohibited for 2 and 6 hours, respectively, before elective cesarean delivery.
Preoperative carbohydrate supplementation	Oral carbohydrate fluid supplementation 2 hours before cesarean delivery could be carried out in nondiabetic pregnant women.
INTRAOPERATIVE CARE	
Preoperative surgical site infection prophylaxis	Administration of antibiotic within 60 minutes before skin incision, wound preparation with chlorhexidine-alcohol scrub instead of povidone-iodine solution should be carried out to reduce the surgical site infection risk after cesarean delivery.
Anesthetic management	Regional anesthesia should be primarily considered anesthesia regimen for cesarean delivery.
Maintenance of normothermia	Normothermia during surgery should be maintained via warming of intravenous fluids, forced air warming, and optimizing operating room temperature.
Surgical technique	Appropriate surgical technique should be used to improve surgical outcomes.
Maintenance of perioperative euvolemia	Perioperative euvolemia should be maintained to improve maternal and neonatal outcomes.
Newborn care	Delayed cord clamping, maintenance of normothermia, facilitating the breathing, mother-newborn skin-to-skin contact, and neonatal resuscitation if needed should be carried out in the operating room.
POSTOPERATIVE CARE	
Prevention of nausea and vomiting	Intravenous fluid loading with or without ephedrine or phenylephrine, and lower limb compression could be effective to prevent nausea and vomiting due to hypotension caused by regional anesthesia. Multimodal approach with antiemetic agents should be used for the treatment of postoperative nausea and vomiting.
Postoperative analgesia	Multimodal analgesia with paracetamol and nonsteroidal anti-inflammatory drugs should be used for postoperative analgesia. Opioid use for the postoperative pain control should be avoided.
Early feeding	Early feeding after cesarean delivery is safe and improves the surgical outcomes.
Gum chewing	Gum chewing could be considered when the delayed oral intake is planned.
Perioperative glycemic control	Perioperative tight capillary blood glucose control should be carried out to prevent the impaired maternal and neonatal glucose levels.
Thromboembolism prophylaxis	Pneumatic compression stockings are recommended in all women who underwent cesarean delivery for thromboembolism prophylaxis. Heparin should be used when the venous thromboembolism risk is high.
Early mobilization	Women should be early mobilized after cesarean delivery.
Timing of urinary catheter removal	Immediate catheter removal after cesarean delivery should be considered.
Discharge counseling	Appropriate standardized written counseling should be carried out before patient discharge.



Maternal chronic hypertension is associated with increased the risk of preeclampsia, low birth weight, preterm birth, perinatal death, neonatal intensive care unit admission, and cesarean delivery (11). Preeclampsia occurs about 16% of women with chronic hypertension (12). Preeclampsia also causes severe adverse maternal and fetal complications (13). Therefore, appropriate management of maternal chronic hypertension will improve the maternal and neonatal outcomes. In 2013, ACOG recommended the treatment of maternal hypertension with the blood pressure of systolic ≥ 150 -160 mmHg and diastolic ≥ 100 -110 mmHg (14). Methyldopa, hydralazine, labetalol, and nifedipine could be used antihypertensive drugs in pregnant women (14).

Both preexisting diabetes mellitus and gestational diabetes mellitus increase the risk of adverse maternal and neonatal outcomes. It was reported that the poor glycemic control during pregnancy is associated with increased risk of fetal anomalies, spontaneous abortion, preeclampsia, macrosomia, fetal death, neonatal hypoglycemia, and hyperbilirubinemia (15). Glycemic targets during pregnancy are fasting of <95 mg/dl, postprandial 1- hour of <140 mg/dl, and postprandial 2-hour of <120 mg/dl (16). A meta-analysis showed that the adequate treatment of gestational diabetes mellitus reduces the risk of preeclampsia, fetal macrosomia, cesarean delivery, neonatal hypoglycemia and admission to neonatal intensive care unit (17).

Maternal anemia is associated with preterm birth, low birthweight, perioperative morbidity, and maternal death (18-19). Maternal hemoglobin level of > 10 gr/dl was found associated with 29% decrease in the maternal mortality rate (19). Identifying the cause of anemia and appropriate treatment were strongly recommended by ERAS Society (3).

Smoking is another modifiable factor causing adverse pregnancy outcomes. It was demonstrated that the smoking during pregnancy is associated with spontaneous abortion, intrauterine growth restriction, preterm birth, low birthweight, placental abruption, premature rupture of membrane, placenta previa, and fetal death as well as the adverse childhood outcomes (abnormal cognitive/behavioral/physical development and childhood cancer) (20). Smoking cessation before pregnancy or in early gestational weeks should be strongly recommended.

c. Preanesthetic medication

Aspiration pneumonia is a cause of maternal death in women who underwent cesarean delivery. To reduce the risk of this condition, administration of preoperative antiacid neutralizing gastric acid and H₂ receptor antagonists inhibiting gastric acid secretion is recommended in cesarean delivery cases (3). Sedative premedication causes adverse neonatal outcomes

such as impaired psychomotor function, neonatal hypothermia, low Apgar score, and poor suckling (21). Sedation should not be administered before cesarean section.

d. Preoperative bowel preparation

Preoperative bowel preparation (oral/mechanical) has no benefit to reduce postoperative infection risk in cesarean delivery (22). Bowel preparation should not be carried out before cesarean delivery.

e. Preoperative fasting

Fasting is recommended to prevent vomiting due to anesthesia and aspiration pneumonia before surgery. The European Society of Anesthesiology recommended that the clear fluids and solid foods should be prohibited for 2 and 6 hours, respectively, before elective surgery (23).

f. Preoperative carbohydrate supplementation

Current data is insufficient to recommend preoperative oral carbohydrate supplementation to the pregnant women who undergo cesarean delivery. A meta-analysis showed that oral carbohydrate supplementation before elective abdominal surgery, orthopedic surgery, cardiac surgery, and thyroidectomy was associated with little improvement of surgical outcomes (24). The authors indicated the bias due to inadequate blinding and conflicting results of the studies reviewed. While preoperative carbohydrate supplementation was associated shorter length of hospital stay than the fasting or placebo in the 19 of trials included this meta-analysis, the other 14 trials reported similar length of hospital stay in both groups. On the other hand, studies showed that carbohydrate feeding or supplementation during labor is safe even if it did not improve the labor outcomes (25). In the light of current knowledge, oral carbohydrate fluid supplementation 2 hours before cesarean section could be carried out in nondiabetic pregnant women (3).

3. Intraoperative Care

ERAS pathway in the intraoperative period includes prophylaxis of surgical site infection, anesthetic management, maintenance of normothermia, appropriate surgical technique, maintenance of perioperative euvolemia and newborn care (Table 1).

a. Preoperative surgical site infection prophylaxis

Prophylactic antibiotic use, wound preparation and vaginal preparation should be carried out to reduce the surgical site infection risk after cesarean delivery. First-generation cephalosporin is used antibiotic firstly for this purpose during standard surgical care (4). Although a cesarean delivery without chorioamnionitis or rupture of membrane is considered as clean

incision, cesarean delivery in active phase of labor or second stage of labor and with rupture of membrane or chorioamnionitis is considered as clean contaminated incision. Contamination with vaginal flora in addition to skin flora increases the risk of infection. The first-generation cephalosporin plus azithromycin prophylaxis in these women provides additional reduction in postoperative infection (26). ERAS Society recommended the administration of antibiotics within 60 minutes before skin incision, instead of administration after cord clamping (4). Studies showed that the preoperative use of antibiotics is more effective than using after cord clamping to reduce the risk of endometritis and wound infection (27). There was no sufficient data indicating the higher antibiotic dose use or postoperative antibiotic administration could reduce the infection risk in obese women.

ERAS Society recommended with an antimicrobial soap before hospital admission and the use of the chlorhexidine-alcohol scrub instead of povidone-iodine solution for wound preparation (4). Studies showed lower rate of surgical site infections with the chlorhexidine-alcohol solution than the povidone-iodine solution in cesarean deliveries and other surgeries (28).

Vaginal preparation with antimicrobial solutions decreases the risk of infection in women who underwent cesarean delivery. A Cochrane review reported the reduced risk of postoperative endometritis from 8.3% to 4.3% with vaginal cleansing with povidone-iodine, chlorhexidine or benzalkonium chloride solutions (29).

b. Anesthetic management

Regional anesthesia is strongly recommended anesthesia regimen for cesarean delivery (4). Better pain control, organ function, ambulation, reduced nausea-vomiting and length of hospital stay with regional anesthesia than general anesthesia was reported (30). Neuraxial anesthesia is the regional anesthesia carried out in cesarean delivery and it could be spinal, epidural or combined. While intraoperative pain sensation is lower with spinal anesthesia than epidural (31) more rapid motor recovery reported with combined spinal-epidural anesthesia than spinal anesthesia (32).

Multimodal analgesia could be used for controlling pain sensation postoperatively. Intrathecal opioid use, nonopioid analgesia started in operating room, the transversus abdominis plane block, abdominal nerve blocks with local analgesics are the methods used for pain management (6,33).

c. Maintenance of normothermia

Hypothermia during cesarean delivery could cause both adverse maternal and neonatal outcomes such as wound infection,

cardiac morbidity, coagulopathy, shivering, longer hospital stay, neonatal hypothermia, low umbilical cord pH and low Apgar score (34,35). Thus, maintenance of normothermia during surgery is important. Warming of intravenous fluids, forced air warming, and increasing operating room temperature are recommended during cesarean delivery to prevent hypothermia (4). It was demonstrated that the operating room temperature of 23°C was associated with lower maternal and neonatal hypothermia rates than the temperature of 20°C (36).

d. Surgical technique

During the surgical incision, Joel-Cohen approach should be preferred (4). In this approach, subcutaneous tissue is disturbed, and abdominal fascia is incised only at the midline. The rectus sheath, rectus muscles, and parietal peritoneum are separated with blunt dissection. A small transverse sharp uterine incision 2 cm above the vesical-uterine fold is carried out and then this incision is enlarged laterally by using two fingers. It was found that this approach was associated with less blood loss and shorter operative time than the traditional approach (37). A Cochrane review including 15 studies with heterogeneous methodology compared the outcomes of manual removal of placenta and cord traction or spontaneous delivery of placenta. Lower blood loss and endometritis risk with spontaneous delivery of placenta with gentle cord traction than the manual removal was reported in this review (38).

The uterine incision could be repaired 1 or 2 layer continuous sutures. The postoperative outcomes of the 1 and 2 layer closure were found similar (39). Closure of visceral and parietal peritoneum is not recommended (4). There is insufficient evidence to support the closure of peritoneum and rectus muscle suturing (40,41). It was shown that the closure of peritoneum was associated with longer operative time (40). Less intraabdominal adhesion but increased postoperative pain with rectus muscle re-approximation was reported (41). The abdominal fascia should be repaired with continuous delayed absorbable sutures to reduce the risk of wound dehiscence and incisional hernia (42). Approximation of subcutaneous tissue of ≥ 2 cm in thickness with absorbable sutures was recommended to decrease the wound complications risk (4,43). Subcuticular skin closure instead of staples and negative-pressure wound therapy in obese women could reduce the wound separation and risk of infection (43).

e. Maintenance of perioperative euvoolemia

Maintenance of perioperative euvoolemia is important to improve both maternal and neonatal outcomes. Perioperative hypervolemia can cause maternal pulmonary edema and excess weight loss of newborn in the first days of life (44,45).



Hypotension by spinal anesthesia could reduce uterine blood flow and cause fetal hypoxia and acidosis (46). It was shown that the combination of adequate fluid loading and phenylephrine prevented the hypotension caused by spinal anesthesia and reduced the fetal acidosis risk (47). Multidisciplinary preoperative assessment and careful intraoperative fluid management should be carried out in women with cardiac disease and preeclampsia. Invasive monitoring of blood pressure and cardiac output during the intraoperative and postoperative period could be required in these women (4).

f. Newborn care

ERAS programs in cesarean delivery include the care of two patients, mother and newborn, differently from the other surgeries. The care of newborn should be initiated in the operating room. Optimal timing of cord clamping, maintenance of normothermia, facilitating the breathing, and skin-to-skin contact of mother and baby as soon as possible are the elements of newborn care in the operating room (4). Delayed umbilical cord clamping for at least 1 minute in term infant and 30 seconds in preterm infant could reduce the adverse neonatal outcomes such as anemia in infancy, need of blood transfusion, and hospital mortality. Hyperbilirubinemia is the risk of delayed cord clamping (48). Newborns should be monitored for neonatal jaundice after birth. Immediate cord clamping should be considered in babies who need resuscitation (4).

Prevention of hypothermia reduces the neonatal morbidity and mortality. The body temperature of newborn should be maintained between 36.5°C and 37.5°C after birth (4). In addition, adequate equipment and skilled staff for immediate neonatal resuscitation should be available in the operating room. Spontaneous breathing initiates in 85% of newborns without any intervention, 10% of newborn needs stimulation and 5% of babies need further neonatal resuscitation (49). Routine gastric or airway aspiration is not recommended for vigorous newborn (4). No significant difference was reported between the implementation of routine oro/nasopharyngeal suction and no suction in terms of neonatal mortality, need of resuscitation, neonatal intensive care unit admission, and low Apgar score (50). Secretions and meconium should be aspirated if they obstruct the airway (4). Routine use inspired room air with oxygen is not recommended for vigorous newborns due to harmful effects (51). It was shown that the skin-to-skin contact in the operating room enhanced the mother-infant bonding (52). The mother-newborn skin-to-skin contact should be provided as soon as possible after birth.

4. Postoperative Care

Postoperative ERAS pathway includes prevention of nausea and vomiting, postoperative analgesia, early feeding, perioperative glycemic control, prophylaxis of thromboembolism, early mobilization, timely urinary catheter removal, and discharge counseling (Table 1).

a. Prevention of nausea and vomiting

The incidence of nausea and vomiting during cesarean delivery varies between 24% and 71%. (53,54). These symptoms can cause prolonged operation time, aspiration of gastric content, bleeding, and abdominal organ trauma during surgery (5). Maternal hypotension due to regional anesthesia is the common cause of these symptoms. Intravenous fluid loading with or without ephedrine or phenylephrine, and lower limb compression could be used to prevent hypotension caused by regional anesthesia (55). Antiemetic agents are also useful to prevent intraoperative and postoperative nausea and vomiting. Dopamine antagonists, 5-HT³ antagonists, sedatives, corticosteroids, antihistamines, and anticholinergic agents are effective to reduce nausea and vomiting (55,56). Multimodal approach is more effective than the single agent use. Combination of 5-HT³ antagonists with dopamine antagonists or corticosteroids was reported more effective than 5-HT³ antagonist alone (56).

b. Postoperative analgesia

Postoperative pain is a factor that prolongs recovery, hospital stay in all surgeries. In cesarean delivery, it can prevent early mobilization and care of newborn by the mother (5). Opioid use for the postoperative pain control should be avoided due to its harmful effects such as sedation, respiratory depression, pruritis, nausea-vomiting, constipation, and physical dependence (57). Multimodal analgesia including the combination of paracetamol and nonsteroidal anti-inflammatory drugs should be the first choice for pain control after cesarean delivery (5). This combination was found cheap, useful, leads to fewer side effects than the opioids (58).

c. Early feeding

Studies showed that the early feeding after cesarean delivery is associated with improved bowel activity, maternal satisfaction and reduced length of hospital stay without increased complication rates such as gastrointestinal and infectious complications, although the definition of early feeding varies in these researches (59). While ERAS society recommends

early feeding with regular diet within 2 hours postoperatively (5), resumption of ice chip and/or water within 1 hour and regular diet within 4 hours after cesarean delivery are the SOAP recommendations (6).

d. Gum chewing

Gum chewing enhances the gastrointestinal function after abdominal surgeries. A Cochrane review reported that the gum chewing reduced the time of first flatus and postoperative ileus risk in women who underwent cesarean delivery (60). However, the authors mentioned the low quality of evidence because of the heterogeneous methodology and high risk of bias of the studies included in the review. The initiation time, number and duration of gum chewing varies in these studies. Further, well designed researches with standardized regimens are needed for the final conclusion on this topic. Though, gum chewing could be implemented when the delayed oral intake is planned rather than the early oral intake (5).

e. Perioperative glycemic control

Perioperative tight capillary blood glucose (CBG) control, especially in diabetic women, is strongly recommended by ERAS society for avoiding maternal and fetal hypoglycemia (5). In women with type I diabetes mellitus, perioperative insulin use should not be stopped to prevent ketoacidosis development (5). CBG should be measured every 30 minutes in women who under general anesthesia until the women are fully conscious (61). In diabetic women, CBG < 180-200 mg/dl is recommended in the first day postoperatively (6). There is no sufficient data about the benefit or harm of preoperative oral carbohydrate loading in diabetic women. ERAS society is not recommended the carbohydrate loading before cesarean delivery in this population (3).

After birth, maternal insulin need reduces rapidly, and hypoglycemia risk increases in women using insulin. Therefore, CBG control is important postoperatively. Insulin should be stopped postoperatively in women with gestational diabetes mellitus (5). In women with type II diabetes mellitus, it could be continued with metformin postoperatively (61). In addition, it is necessary to be alert for neonatal hypoglycemia in diabetic women. The blood glucose of newborn should be measured in the postpartum period (5).

f. Thromboembolism prophylaxis

Pregnancy and postpartum period are the two of factors increasing the venous thromboembolism risk. Mechanical and pharmacological methods are available to reduce the thromboembolism risk after cesarean delivery. ERAS society recommends the routine use of pneumatic compression

stockings in all women who underwent cesarean delivery to prevent thromboembolic diseases (5). It was shown that the universal pneumatic compression stocking use significantly reduced the death risk due to pulmonary thromboembolism in the post-cesarean period (62). Routine heparin use for this purpose is not recommended by ERAS society (5). Unfractionated heparin or low molecular weight heparin should be used in women with high risk of venous thromboembolism only (62).

g. Early mobilization

Early mobilization after abdominal surgery reduces the risk of venous thromboembolism, pulmonary complication, and length of hospital stay (63) ERAS society and SOAP recommended early mobilization in women who underwent cesarean delivery, although there is not sufficient data in this population (5,6).

h. Timing of urinary catheter removal

Urinary catheterization during cesarean delivery widely carried out with the aim of measuring urinary output, reducing urinary tract injuries, and postoperative urinary retention. However, studies showed that the urinary catheter placement increased the rates of urinary infection, the time of patient ambulation, first voiding, and length of hospital stay postoperatively (64). Another randomized trial showed that the catheter removal 12 hours after surgery was associated with the more bacteriuria, urinary symptoms, discomfortable micturition, delayed postoperative ambulation, delayed first voiding, and delayed hospital discharge than the immediate catheter removal (65). Therefore, ERAS society recommended immediate catheter removal after surgery if placed during cesarean delivery (5).

i. Discharge counseling

ERAS society recommended the use of written standardized discharge instructions to improve postoperative care of women who underwent cesarean delivery (5). Patients should be informed about the sign and symptoms of surgical site infection, activity restriction, medications, breastfeeding, and mother-infant bonding. Both mother and infant should be discharged at the same time if there is no obstacle.

5. Conclusion

ERAS program has been developed to optimize patient care and enhance the surgical outcomes. Previous reports showed that this multidisciplinary program could be implemented successfully in cesarean delivery. The antenatal-preoperative, intraoperative and postoperative pathways of the program improved both maternal and neonatal outcomes after surgery. Considering the increasing incidence of cesarean delivery,

the clinical and healthcare system effects of ERAS program are undeniable. However, due to the heterogeneity in the methodology of existing researches, a final standardized care program has not yet been completed. Further studies in this area are needed to create optimized perioperative care and enhanced recommendations.

Author contribution

Study conception and design: TK, MÇİ, and YEÜ; data collection: TK, MÇİ, and YEÜ; analysis and interpretation of results: TK, MÇİ, and YEÜ; draft manuscript preparation: TK, MÇİ, and YEÜ. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of interest

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