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Multimodal Approach for Pain Relief after Cesarean Section

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Abstract: Post-cesarean delivery pain relief is important. Pain may impair the mother's ability to optimally care for her infant in the immediate postpartum period and may adversely affect early interactions between mother and infant. It is necessary that pain relief be safe and effective with no adverse neonatal effects in breast-feeding women. Optimal postoperative analgesia has a significant impact on patient recovery and outcomes after cesarean delivery. Multimodal analgesia is the core principle for cesarean delivery and pain management due to increasing efficacy and safety. The most commonly used modalities are: Systemic administration of analgesic drugs (opioids- non opioids), neuraxial injection of opioid and/ or adjuvants, regional blocks and non-pharmacological methods of analgesia. Postsurgical recovery has evolved from focusing on a one-dimensional goal of a VAS pain score ≤3/10 to a more multidimensional approach. The fundamental goal of experiencing less pain not only reduces an patient's suffering but also improves recovery with faster return to the daily activity, including maternal-infant bonding, returning home, and better daily activity hence, the reliance on VAS on active movement arouse. The postoperative pain control is a vital part in Enhanced recovery of cesarean delivery (ERAC). Regional blocks useful for cesarean surgery have been shown to have significant improvement on ERAC when used on early ambulation.

Keywords: Multimodal Approach, Pain Relief, Cesarean Section

Introduction: The rate of cesarean delivery has been increasing over the past decades, and it is one of the most commonly performed surgeries in the world. The causes to explain this higher trend including an increase in cesarean performed for maternal request, increased number of high-risk expectant mothers, changes in provider practice patterns, and the obstetrical medicolegal environment (1).

Pain following cesarean delivery is a complex experience that is personalized to each patient. The degree of tissue injury triggers a response in the pain matrix, forming peripheral sensitization and central pain pathways to fear, anxiety, and frustration. Patients have reported concerns about pain during and after cesarean delivery as their highest priority.

The intensity and duration of pain experience increase the likelihood of greater opioid use, delayed recovery and impeded maternal and fetal bonding. Furthermore, severe acute pain is a strong risk factor for postpartum depression and chronic pain which results in long-term psychological, social, and economic adversities Therefore, optimal pain control is a key priority on both humanitarian grounds and for efficient health service delivery (1).

Post-cesarean delivery pain relief is important. Good pain relief will improve mobility and can reduce the risk of thromboembolic disease, which is increased during pregnancy. Pain may also impair the mother's ability to optimally care for her infant in the immediate postpartum period and may adversely affect early interactions between mother and infant. Pain and anxiety may also reduce the ability of a mother to breast-feed effectively. It is necessary that pain relief be safe and effective, that it not interfere with the mother's ability to move around and care for her infant and result in no adverse neonatal effects in breast-feeding women **(2)**.

The most commonly used modalities are:

1. **Systemic administration of analgesic drugs** (opioids- non opioids), either by intramuscular (IM) injection, intravenous (IV) injection, oral or patient-controlled analgesia (PCA).
2. **Neuraxial injection of opioid and/ or adjuvants** as a part of regional anesthesia for cesarean delivery.
3. **Regional blocks:** transversus abdominis plane block, Rectus sheath block, Erector spinae block, quadratus lamboram block and field infiltration.
4. **Non-pharmacological methods of analgesia:** Acupuncture, aromatherapy, transcutaneous electrical nerve stimulation (TENS) and music therapy **(3).**

1- Systemic Administration of analgesic drugs:

Systemic administration of analgesics, in most cases opioids, is a commonly used modality for immediate post-cesarean delivery pain relief, particularly after general anesthesia. Analgesics may be given by IM or IV injection. In some women, simple oral administration may be sufficient if bowel function is normal. The advantage of systemically administered analgesics is their ease of administration, low cost, and long history of use in postpartum women. Women receiving systemically administered analgesia usually do not require heightened vigilance for delayed adverse side effects that may occur with neuraxial techniques, although pain relief is less effective **(2).**

A. Opioids:

I. Intramuscular/Subcutaneous opioids

Intramuscular (IM) or subcutaneous administration of opioids is the most frequently used modality for post-cesarean delivery pain relief. However, there are some serious limitations to their use. First, drug administration requires injection, often repeated, which may be uncomfortable for many women. Second, there is a large inter-individual variability in opioid

pharmacokinetics and drug requirements, which is problematic for estimating an effective dose regimen. Furthermore, with IM administration, there are peaks and valleys in opioid blood concentration that can affect pain relief and the incidence of side effects **(4).**

At Parkland Hospital, all women delivered by cesarean section were assigned to 1 of 4 different pain management strategies: 1- IM meperidine, 2- PCA meperidine, 3- IM morphine, and 4- PCA morphine. A combination of methods was used to compare those pain management strategies; survey questionnaire, Likert scale responses and VAS scores. The percentage of women reporting moderate or worse pain (VAS scores 4 or more) was significantly lower in PCA meperidine compared with IM meperidine group. Women who received morphine reported less severe pain compared with meperidine, regardless of route of administration. The study concluded that pain relief was superior with the morphine regimens either IM or PCA **(5).**

While the regular subcutaneous administration of a potent opioid, as morphine, was found to be a simple, inexpensive, and relatively effective method of providing good postoperative analgesia in the absence of more sophisticated methods. In a study morphine was used in 571 patients (77.6%), pethidine in 140 patients (19%) and tramadol in 25 patients (3.4%). Eighty percent of the patients gave a satisfaction score (for effective pain relief) of either excellent or good on a 4-point satisfaction scale, ranging from excellent to unsatisfactory **(6).**

II. Intravenous opioids:

- **Intravenous injections:**

Despite years of advances in pain management, the mainstay of postoperative pain therapy in many settings is still IV opioids. The most commonly used intravenous opioids for postoperative pain are morphine, hydromorphone and fentanyl. Morphine is the standard choice for opiates and is widely used. It has a rapid onset of action with peak effect occurring in 1 to 2 hours. Fentanyl and hydromorphone are synthetic derivatives of morphine and are more potent, have a shorter onset of action, and shorter half-lives compared with morphine **(7).**

All opioids have significant side effects that limit their use. The most important side effect is respiratory depression that could result in hypoxia and respiratory arrest. Hence, regular monitoring of respiration and oxygen saturation is essential in patients on opioids postoperatively. In addition, nausea, vomiting, pruritus, and reduction in bowel motility leading to ileus and constipation are also common side effects of these medications. With the development of enhanced recovery protocols, primarily opioid-based regimens are being challenged by other agents and approaches to postoperative pain management **(7).**

Morphine for example, is widely used to control moderate-to-severe postoperative pain and the use of small IV boluses of morphine in the post-anaesthesia care unit allows a rapid titration of the dose needed for adequate pain relief. The essential principle of a titration regimen must be to adapt the morphine dose to the pain level. More than 90% of the patients have pain relief using a protocol of morphine titration. Sedation is frequent during IV

morphine titration and should be considered as a morphine-related adverse event and not evidence of pain relief. The incidence of ventilatory depression is very low when the criteria to limit the dose of IV morphine are enforced. Morphine titration can be used with caution in obese patients. In practice, IV morphine titration allows the physician to meet the needs of individual patients rapidly and limits the risk of overdose making this method the first step in postoperative pain management **(8).**

- **Intravenous Patient Controlled Analgesia (PCA):**

Many limitations encountered with IM administered opioids can be overcome with the use of patient-controlled IV analgesia (IV PCA), which requires that the patient demand a small bolus of opioid administered IV by a device. The device is programmable for the dose administered, a lockout interval, whether a basal infusion of drug is given, and as an added protection, maximum dosages within specified time periods **(2).**

The advantage of IV PCA is that it reduces the peaks and valleys in blood drug concentrations and pain relief observed in post-cesarean delivery women, in part by bypassing the patient-nurse-injection loop. Pain relief with IV PCA has been shown to be superior to conventional IM opioids for pain relief in women having had a cesarean delivery. The reason for patient satisfaction to be greater with IV PCA as compared with epidural opioid is greater autonomy and control of the woman over her care, something that is important as she balances her needs to care for her infant. On the other hand, the more frequent incidence of pruritus with epidural morphine as compared with IV PCA may have resulted in less maternal satisfaction with the former **(9).**

The most significant limitations to the use of IV PCA in postpartum women relate to the device itself and patient ability to use it correctly. The latter requires patient education understanding. The device itself has an added cost over the use of conventionally administered opioids. In contrast, IV PCA may reduce the work of floor personnel particularly on a busy postoperative floor. Another limitation of IVPCA is that some devices may be cumbersome and women may find it difficult to ambulate and care for their infant **(2).**

B. Non-Steroidal Anti-Inflammatory Drugs:

Pain after cesarean delivery may have at least two components: postoperative (somatic) pain from the wound itself and visceral pain arising from the uterus. Although somatic pain may be relieved by opioids, visceral pain may be more difficult to treat. NSAIDs are effective for relieving pain related to menstrual cramping and, as a result, there has been interest in the use of NSAIDs to treat a component of pain after cesarean delivery. Unfortunately, NSAIDs alone are insufficient to effectively treat post-cesarean delivery pain. However, inclusion of NSAIDs in a multimodal approach to pain relief after cesarean delivery has been very successful both in improving the quality of analgesia resulting from systemic or neuraxially administered opioids and reducing side effects **(2).**

For instance, use of IM diclofenac 75 mg results in a morphine-sparing effect and a decrease in side effects related to morphine use **(2).**

In a double-blind randomized study, comparison between intramuscular ketorolac and intramuscular pethidine for analgesia after elective caesarean section. Analgesia was assessed at intervals up to six hours, using VAS, while duration of analgesia was taken as the time until the patient requested additional analgesia. There was no difference in the duration of analgesia between groups. Pain VAS and overall assessment of analgesia was similar between groups, although more side-effects (nausea, dizziness) were noted in the pethidine group. Ketorolac and pethidine provided similar but variable quality of analgesia after caesarean section **(10).**

Another study of combining non-opioid analgesics with neuraxial opioids for analgesia after caesarean delivery was done. A randomized, double blind, placebo-controlled clinical trial was conducted among women having elective caesarean delivery. Patients received placebos (group C); intravenous parecoxib 40 mg then oral celecoxib 400 mg at 12 hours (group PC); intravenous paracetamol 2 g then oral 1 g six-hourly (group PA); or these regimens combined (group PCPA). Dynamic pain scores did not differ between groups but requirement for, and dose of, supplementary oral tramadol was least in group PCPA **(11).**

Celexocib, ibuprofen, ketoprofen and naproxen were all used as NASIDs in the non-opioid analgesia versus placebo studies in control of pain after cesarean delivery **(12).**

C. Paracetamol:

A study is to compare the efficacy of intravenous infusion of paracetamol in comparison with pethidine as post cesarean section analgesia was carried out on 2018. Ninety labouring women who seek post C.S analgesia were divided into two groups: 1st group received 1 gm. of intravenous paracetamol. 2nd group received 50 mg pethidine IM. Results showed that paracetamol is as effective as pethidine in relieving pain after cesarean section. Prescribing paracetamol in the form of intravenous infusion can be suggested as a suitable alternative for opioid after the operation **(13).**

D. Gabapentin

Gabapentin is an anticonvulsant drug with significant analgesic properties. It binds to presynaptic voltage-gated calcium channels in the dorsal root ganglia of the spinal cord and prevents release of excitatory neurotransmitter. It is an established analgesic in chronic and neuropathic pain conditions. The pre-operative use of oral gabapentin has been shown to decrease acute pain after various surgical procedures. There are some studies in literature exploring the role of gabapentin in post-CS analgesia have conflicting results. While some studies concluded significant improvement in pain score and maternal satisfaction in first 48 h postoperatively with a single dose of 600 mg **(14)**, the other studies showed less beneficial effect of gabapentin **(15).**

A systematic review was performed to include all randomized trials examining the effect of perioperative gabapentin on post cesarean delivery pain control. The primary outcome was the analgesic effect of gabapentin on post cesarean delivery pain, measured by VAS. All studies included healthy pregnant women ASA II undergoing spinal anesthesia for cesarean delivery at term. Participants were randomized to either 600 mg oral gabapentin or placebo

preoperatively and in one study the medications were also continued postoperatively. Pooled data showed that women who received gabapentin prior to cesarean delivery had significantly lower VAS pain scores at 24 h on movement. There was no significant between-group difference in use of additional pain medications, supplemental opioids, and maternal or neonatal side effects. There was higher pain control satisfaction at 12 and 24 h in the gabapentin versus placebo groups **(16).**

E. Ketamine

Studies showed that IV ketamine if used prei-operatively has the effect of decreasing the total morphine consumption postoperatively and the total analgesic requirement but failed to show significant difference if used alone **(17).**

A meta-analysis aimed to evaluate the clinical efficacy of ketamine versus control in cesarean section anesthesia for reducing the postoperative pain and analgesia was done on 2020. Meta-analysis showed that the pain score in the ketamine group was less than that of the control group. Application of ketamine during cesarean section also resulted in decreased consumption of morphine when compared with the control group. In addition, the first time required for analgesia was significantly longer in the ketamine group than that of the control. Overall, ketamine supplementation reduces pain, reduces morphine consumption and prolongs the postoperative analgesia **(19).**

F. Dexamethasone:

Glucocorticoids can modify the stress response and reduce inflammation. Dexamethasone, a commonly used antiemetic, interferes with the cyclooxygenase and lipoxygenase pathways through phospholipase inhibition and has been proposed to modulate postoperative pain in surgical patients **(19).**

A double-blind prospective randomized clinical trial was performed on 60 patients who were candidate for elective cesarean section. Patients were randomly assigned into two groups: A (treatment: 8 mg IV Dexamethasone) and B (control: 2 mL normal saline). In both groups, pain (based on VAS) and vomiting severity were recorded in different time points during first 24 h after operation. The results indicated that between group comparisons, significant differences in terms of pain severity and heart rate were noticed which in case group were lower than the control group. These results concluded that IV Dexamethasone could efficiently reduce post-operative pain severity and the need for analgesic consumption and improve vital signs after cesarean section **(20).**

2- Neuraxial Analgesia:

It has been almost 25 years since neuraxial opioids first underwent rigorous clinical study for use in humans. Since that time, neuraxial techniques of providing post-cesarean delivery analgesia have become a logical outgrowth of the increased use of regional anesthesia for the procedure. For instance, a review of the most recent Obstetric Anesthesia Workforce Survey reports a sizeable increase in the use of spinal and epidural over general anesthesia for cesarean delivery from 1979 to 1990. Similarly, data from the United Kingdom show that regional anesthesia is used 94.9% of the time for elective and 86.7% of the time for emergent

cesarean delivery. Addition of opioid, like morphine, to intrathecal and/or epidurally administered local anesthetic provides an easy and effective means to maintain prolonged postoperative analgesia. Neuraxial techniques may be used for post-cesarean delivery pain relief even in women having general anesthesia, if they so desire, once they are awake **(2).**

A- Intrathecal analgesia:

i. Intrathecal Opioids:

Besides local anesthetics, opioids have often been administered in the subarachnoid space. Intrathecal opioids can improve intraoperative anesthesia quality and prolong postoperative analgesia. Conversely, they can cause undesirable effects, including nausea, vomiting, pruritus, and respiratory depression. Various opioids have been used as adjuncts to local anesthetics, but their comparative effectiveness remains unknown **(21).**

Studies showed the effect of opioids used as adjuncts to spinal anesthesia in cesarean section on clinically important outcomes. Regarding primary outcome (duration of complete analgesia, defined as time to VAS > 0), opioids, including fentanyl, sufentanil, and morphine, significantly prolonged the duration of complete analgesia compared with the placebo when added alone to local anesthetics with morphine ranking first. The fentanyl and morphine combination showed no prolonging effect on the duration of complete analgesia compared with the use of fentanyl alone **(21).**

In terms of time until VAS ≥ 4, fentanyl, meperidine, and sufentanil equally extended the time compared with the placebo. The 24 h opioid consumption was not different between diamorphine and morphine, morphine was associated with longer duration of time to the first analgesic use compared with diamorphine, as well as fentanyl and sufentanil. Among five opioids, morphine ranked first on both the cumulative postoperative opioid consumption and time to first analgesic use; thus, morphine seems to be most suitable agent for improving postoperative analgesia **(21).**

Opioid-related adverse effects as nausea were not affected by the addition of intrathecal opioids. One of the most serious adverse events is respiratory depression which was most significant with sufentanil and morphine. While in case of pruritus, all opioids, except for diamorphine were associated with a significant increase in the incidence of pruritus **(22).**

ii. Inrathecal α_2 agonists:

Clonidine.

Clonidine exerts its anti-nociceptive effect by stimulating the α_2 adrenergic receptor and modulating pain pathways in the dorsal horn. It is effective for both somatic and visceral pain. The addition of clonidine (up to 150 μg) alone to spinal local anesthetic for post-cesarean delivery analgesia has been disappointing. Concerns exist proscribing the use of clonidine during the second and third trimester because of the potential for fetal injury and death **(23).**

Dexmedetomidine.

Dexmedetomidine can be administered intravenously or intrathecally during spinal anesthesia, but there is some controversy about which method should be used during

anesthesia for pregnant women. The use of dexmedetomidine by the intravenous route has been reported to result in hemodynamic instability **(24).**

Intrathecal dexmedetomidine can effectively reduce the occurrence of shivering during cesarean section under spinal anesthesia, and it has no significant effect on the occurrence of nausea and vomiting during cesarean section. Moreover, the occurrence of bradycardia and hypotension did not increase, indicating that intrathecal dexmedetomidine does not affect hemodynamics during cesarean section **(24).**

A study aimed to determine the effect of adding dexmedetomidine to intrathecal bupivacaine on the postoperative analgesia, sedation, and incidence of side effects in cesarean section was carried out. 40 adults full-term pregnant female were randomly classified into two equal groups: Group [D]: Patients received intrathecally bupivacaine and dexmedetomidine. Group [F]: Patients received intrathecally bupivacaine and fentanyl. The postoperative analgesic effect time was longer in group D than in group F. As a result adding intrathecal dexmedetomidine to bupivacaine for spinal anesthesia has a better postoperative analgesia without any significant adverse effects **(25).**

iii. Intrathecal dexamethasone:

Epidural and intrathecal steroids are used to reduce chronic pain in some studies, intrathecal dexamethasone increased duration of sensory block and postoperative analgesia. Although intrathecal dexamethasone is used to control chronic pain; studies have been conducted on the effects of sensory block and postoperative pain in patients undergoing surgery **(26).**

In a study at Ain-Shams university, the addition of intrathecal dexamethasone to bupivacaine significantly improved the duration of sensory block in spinal anesthesia and the first analgesic dose prescription in the case group was significantly longer than that in the control group, the motor block duration in the study group was significantly prolonged when compared with control group. There was no difference in onset time between the two groups and the addition of dexamethasone cause no complications **(27).**

iv. Intrathecal ketamine:

Bion **(28)** first used spinal ketamine for victims of war surgery in a human population. He showed that intrathecal ketamine 50 mg produced significant analgesia without interfering with cardiovascular and respiratory function. However, the occurrence of central side-effects and the short duration of surgical analgesia limited the usefulness of spinal ketamine **(28).**

Spinal ketamine binds to the phencyclidine site of the NMDA receptor-gated calcium channel and inhibits the NMDA receptors noncompetitively. It also acts at opiate, monoaminergic receptors and voltage-sensitive calcium channels. Its direct axonal blocking effect produces some local anaesthetic activity and contributes to the analgesic effect of spinal ketamine **(29).**

A study on pregnant women scheduled for spinal anesthesia for cesarean section where intrathecal ketamine (30 mg) + midazolam (1 mg = 2CC) or 1mg midazolam (2CC) alone were compared. Pain scores at first, second and third hours after CS operation, analgesic

requirement and drug adverse effects were recorded in all patients. Ketamine group had significant pain relief properties in comparison with midazolam group in first hours after cesarean section. Total dose of meperidine consumption in women of ketamine group was significantly lower. There were no significant drug side effects in participated patients **(30).**

B- Epidural analgesia:

The combination of epidural opioids with local anesthetics is a well-known drug formula for cesarean section and subsequent post-cesarean analgesia. Epidural opioids may enhance the sensory and motor blockade of epidural local anesthetics and decrease the requirement for local anesthetics for post-cesarean analgesia. Even a single dose of epidural morphine provides excellent prolonged pain relief. Epidural morphine (4 mg) is recommended for analgesia following cesarean delivery with an acceptable side effect profile. However, adverse events associated with epidural morphine, including nausea, vomiting and pruritus, still frequently occur **(31).**

When using an epidural technique for cesarean delivery, opioids can be administered either as a bolus or as a continuous infusion for postoperative pain relief. Some mothers find that the epidural catheter and infusion equipment reduce their mobility, thus limiting the utility of indwelling epidural catheters for postoperative pain, especially for mothers who are bothered by it and wish to be unencumbered when ambulating and caring for and nursing their infants **(23).**

In a study intending to compare the performance of three epidural therapeutic schemes (0.1% ropivacaine combined with epidural morphine - 0.2% ropivacaine combined with epidural morphine - morphine bolus) in pain intensity and its adverse effects in the early postoperative period of cesarean section. A retrospective observational study was carried out. The sample included 204 women who underwent cesarean section after previous epidural catheter placement. Pain intensity in rest, movement at 24 and 48 hours, and adverse effects were recorded. Analysis revealed no differences in mean pain scores between groups on the first and second postoperative days. The incidence of adverse effects was significantly lower in the morphine bolus group. Thus, the study concluded that epidural morphine therapy is an effective option with an adequate safety profile. The addition of a local anesthetic seems to offer no benefit in this context, increasing the incidence of adverse effects **(32).**

3- Regional blocks:

Local anesthetic infiltration or regional blockade for dealing with pain after caesarean delivery has become more popular. They can relieve pain without significant adverse effects, with the added advantage of a small component of visceral analgesia with some techniques. The various sites of injection include wound infiltration (bolus or infusion); ilio-inguinal nerve (either alone or in combination with iliohypogastric nerve); transversalis fascia plane; transverse abdominis plane; quadratus lumborum plane; rectus sheath and erector spinae **(33).**

A. Local infiltration of the wound

Local anesthetics (LA) are injected via catheters placed in surgical wounds for post-operative analgesia to provide analgesia by both single shoot and continuous infiltration **(34).**

Meta-analysis evaluated the efficacy of LA in CS. Local anaesthetic wound infiltration in Cesarean section was associated with significant lower morphine consumption, lower rate of nausea but not with lower pain scores comparable to the placebo group based on a group of heterogeneous studies **(34).**

B. Transversus abdominis plane blockade (TAP block)

The TAP block is a peripheral nerve block designed for anesthesia of the nerves supplying the anterior abdominal wall (T6 to L1). First it was described in 2001 by Rafi as a traditional blind landmark technique using the lumbar triangle of Petit **(35).** Local anesthetic is injected between the internal oblique and transverse abdominis muscles just deep the fascial plane where the sensory nerves pass **(figure 1) (36).**The surface anatomy landmark technique has been superseded by ultrasound-guided. In the caesarean delivery population, TAP blockade is the most studied trunkal nerve block **(35).**

Multiple studies using ultrasound guided TAP block after caesarean section were associated with longer time for demand of first analgesia and reduction in total morphine use in 24 h in the active group compared with the placebo group **(37).** VAS scores also reduced in the active group compared to placebo group **(36).** Similarly, a study was conducted in 2008 using TAP block after caesarean delivery by the blind approach. The study confirmed the usefulness of TAP block as seen by the reduced VAS and requirement for morphine **(38).**

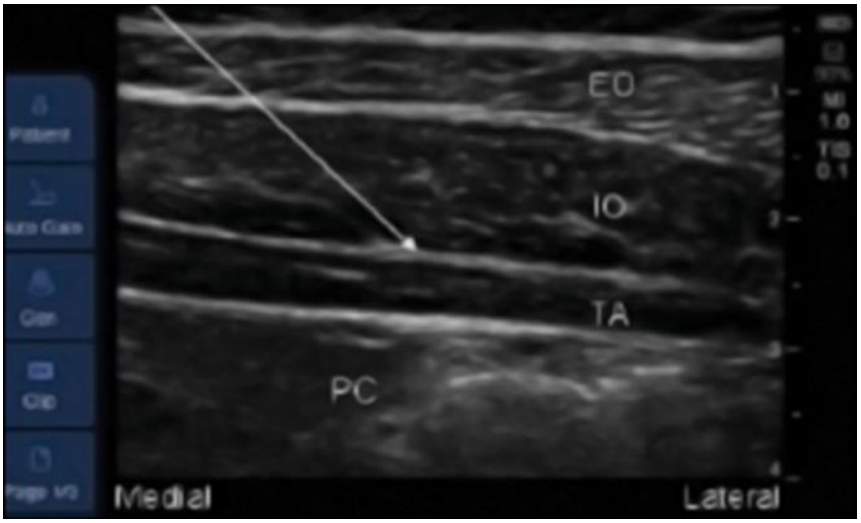

Figure (1): Ultrasound guided image of TAP block **(36).**

C. Quadratus lumborum blockade (QLB)

For the anterior QLB, the patient is placed in the lateral decubitus position. The provider moves the probe posteriorly to identify the "shamrock sign." They then insert the needle in an in-plane approach through the qudratus lamborum (QL) muscle between QL and psoas

major. Correct needle placement and injection results in the spread of local anesthetic between these 2 muscles **(39) (40).**

For the posterior QLB, the patient is positioned lateral as with the lateral QLB. The provider identifies the posterior border of QL and places the needle tip at that point. Proper placement should result in the spread of local anesthetic into the interfascial triangle. For the Intramuscular QLB, the patient should be placed in the supine or lateral decubitus position. Following identification of QL, the practitioner inserts the needle in an in-plane approach and an anterolateral to posteromedial direction with an injection of a local anesthetic directly into the muscle **(figure 2) (40).**

Studies utilized various approaches (two laterals, eight posterior and two anterior) of the QLB on abdominal incisions including pfannestiel incision. Pooled results from six of these studies showed a reduction in 24-h opioid consumption with QLB in the absence of long-acting neuraxial opioids. Pooled data from the other six studies also showed a significant reduction in 48-h opioid consumption with QLB. Resting and on movement pain scores (0–10) were significantly lower with QLB compared with placebo or no block **(41).**

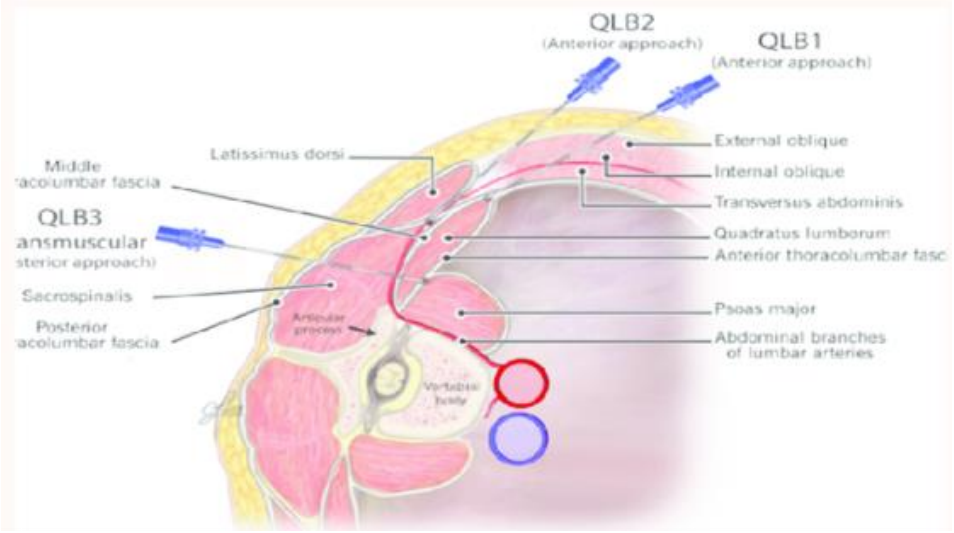

Figure (2): Quadratus lamborum block**(40)**

QLB*: Quadratus lamborum block. QLB1: Application of local anesthetics on the lateral side of QLM in the area of its contact with the transversalis fascia. QLB2: Application of medication on the posterior side of the QLM between the QLM and the medial lamina of thoracolumbar facia. QLB3: Application of medication at the front of the QLM.

D. Ilio-inguinal and iliohypogastric blockade (IIIH)

The ilioinguinal and iliohypogastric nerves are seen in close proximity to one another as two small round hypoechoic structures with a hyperechoic border on the US image **(figure 1) (42).**

. They lie in the plane between the internal oblique muscle and the transversus abdominis muscle close to the anterior superior iliac spine **(43).**

Isolated ilioinguinal nerve blocks have been superseded by combined IIIH blockade, without significantly increasing time taken to perform the procedure or adding to the level of difficulty. Studies have been conducted IIIH as part of a multimodal analgesia regimen compared with placebo showed reduced 24-h morphine consumption associated with IIIH blockade. Pain scores were lower in the IIIH group at 12 h. Time to first analgesia was reduced with IIIH **(44).**

In one of the studies, the effect of ultrasound-guided bilateral ilioinguinal and iliohypogastric nerve block on pain reduction after CS was assessed. 64 cases of elective CS were classified into two groups. The block group underwent the nerve block, and the control group did not. Pain scores during rest and movement together with morphine consumption, were all significantly lower in the block group than in controls, especially within the first 12 hours following the operation. Time to the first rescue analgesia was significantly longer in the intervention group than in the other group **(44).**

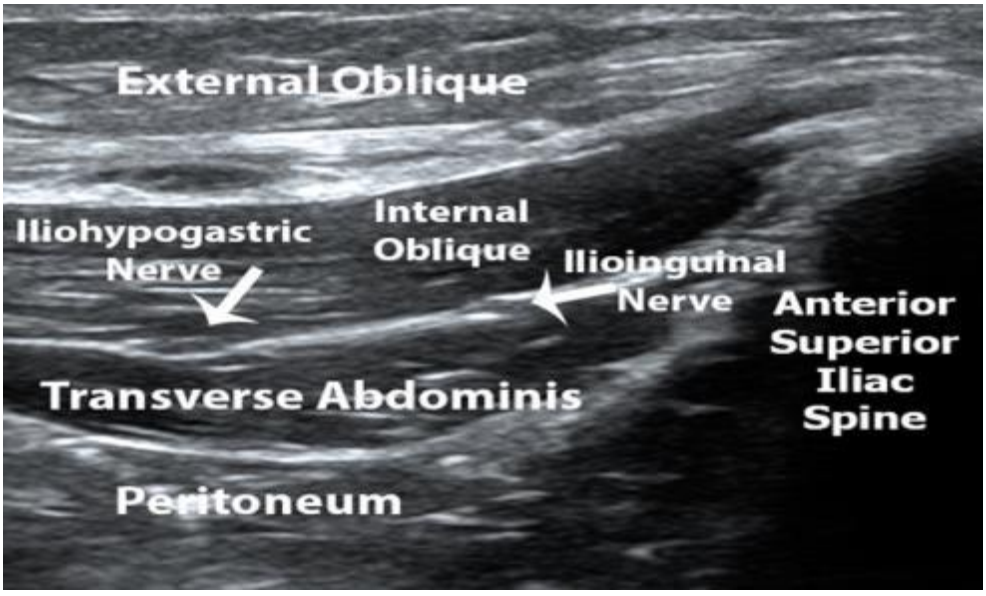

Figure (3): Ilioinguinal and iliohypogastric nerves **(42).**

E. Erector spinae plane blockade (ESPB)

Patients in the ESPB undergo bilateral ESPB at the level of the ninth thoracic transverse process using an US. Patients turned to a lateral position, and the transducer is positioned vertically 3 cm to the side of the midline to visualize the muscles of the back the transverse process, and the pleura among the two transverse processes. Then, after needle is introduced in the cranial-caudal direction toward the transverse process (T9) using the in-plane method till the needle tip crosses all the muscles (figure 4) **(46)**. After ensuring negative aspiration, interfascial injection of LA is performed. The procedure is repeated on the opposite side of the back **(47).**

Bilateral ultrasound-guided ESP blocks were performed at the level of T9 and compared with long-acting neuraxial opioid after cesarean delivery. During the first 8 h, resting VAS (0–10)

pain scores were 0.31 higher in the neuraxial opioid group, between 0 and 24 h postoperatively; resting VAS pain scores were 0.25 higher in the neuraxial opioid group. Opioid consumption was also decreased and time to first analgesia was increased with ESP blockade compared with long-acting neuraxial opioid. **(47).** While this technique shows promise based on results from this well-designed study, further adequately powered studies are needed to corroborate these findings before this technique can be recommended for routine use. Furthermore, comparisons to other blocks in the presence and absence of neuraxial opioid are needed to inform the future role of this technique. **(48).**

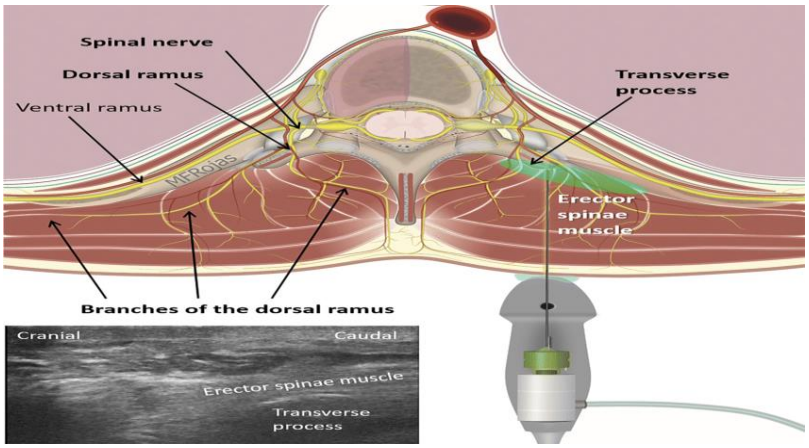

Figure (4): Erector spinae block **(46).**

F. Rectus sheath blockade (RSB)

The rectus sheath nerves are the terminal branches of the myocutaneous nerves (T8–L1) supplying the lower two-thirds of the anterior abdominal wall, including the muscle layers and the parietal peritoneum. They enter the rectus sheath through its lateral border (linea semilunaris) and pass towards the linea alba. Within the rectus sheath the nerves lie between the rectus abdominis muscle and the posterior wall of the sheath, and supply the central abdominal wall. The lateral border of the rectus sheath in the abdominal wall is marked by the transition from the triple layer of muscle (external oblique, internal oblique and transversus abdominis) on the left side (lateral) of the scan to the single layer of muscle (Rectus abdominis) on the right (medial). The plane for injection between the rectus abdominis and the posterior wall of the rectus sheath is indicated as rectus abdominis plane **(figure 5) (49).**

In 131 women undergoing elective caesarean delivery, a randomized controlled trial reported the use of rectus sheath blockade as compared with a placebo block performed by a surgeon under direct vision with and without long-acting neuraxial opioid. Rectus sheath blockade without intrathecal morphine was associated with a higher area under the curve as compared with rectus sheath blockade with long-acting neuraxial opioid **(48).**

A study aimed to evaluate the effects of ultrasound-guided rectus sheath block in gynecological surgery with Pfannestiel incision was performed by **CiCüneyitou et al., (50)** ASA I–II patients scheduled for a gynecological surgery with Pfannestiel incision were

included in this study. Patients were randomly divided into three groups. In Group ultrasound-guided rectus sheath block (UR) patients (n=25), ultrasound-guided rectus sheath block was performed. In Group surgical rectus sheath block (SR) patients (n=25), surgical rectus sheath block was applied. In Group tramadol (T) (n=25) patients, tramadol was intravenously administered 30 min before the end of surgery. Pain scores, total tramadol consumption, supplemental analgesic requirement and side effects were postoperatively evaluated. VAS scores were significantly lower in Group UR than those in Groups SR and T. Total tramadol consumption was significantly lower in Groups UR and SR than that in Group T. There was no significant difference in the incidence of side effects. This study demonstrates that ultrasound-guided rectus sheath block helps to provide the effective analgesia without any side effects compared with surgical rectus sheath block and intravenous tramadol for gynecological surgery with Pfannestiel incision **(50).**

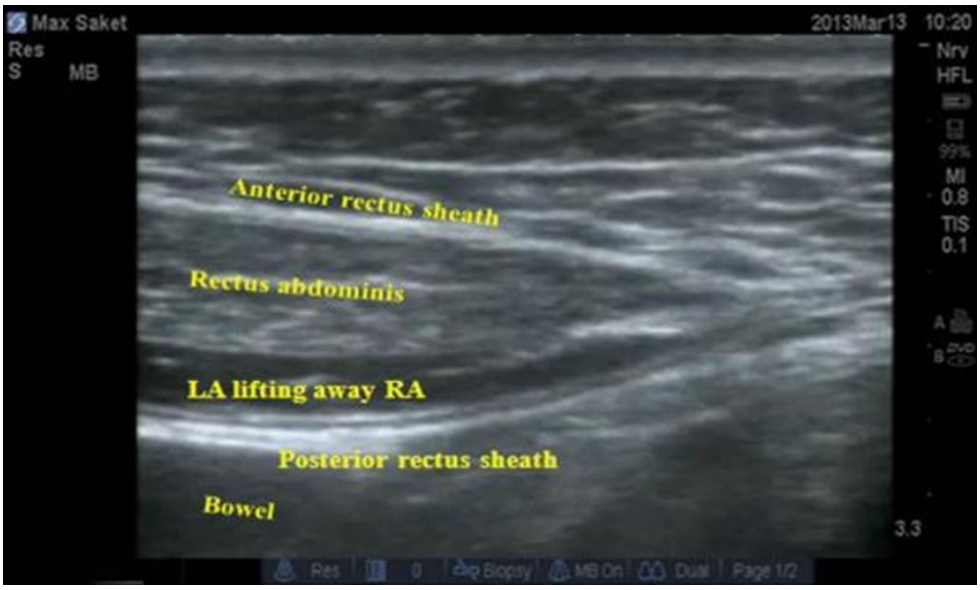

Figure (5): Ultrasound image of rectus sheath block **(49)**.

4- Non-pharmacological methods of analgesia:

I. Acupuncture or acupressure

Studies are uncertain if acupuncture versus no treatment or acupuncture plus analgesia versus placebo plus analgesia has any effect on pain because the quality of evidence is very low. Acupuncture plus analgesia versus analgesia alone may reduce pain at 12 hours and 24 hours **(3).**

II. Aromatherapy

Aromatherapy may reduce pain at 12 and 24 hours when compared with placebo plus analgesia. It is uncertain if aromatherapy compared with placebo plus analgesia has any effect on adverse effects (anxiety) **(3).**

III. Music therapy

Music plus analgesia, compared with placebo plus analgesia, may reduce pain at one hour and 24 hours. It is uncertain if music plus analgesia, compared with placebo plus analgesia, has any effect on the risk of adverse effects (anxiety) or on heart rate **(3).**

IV. Transcutaneous electrical nerve stimulation (TENS)

TENS may reduce pain at one hour after the intervention, compared with no treatment. TENS plus analgesia, compared with placebo plus analgesia, may reduce pain, heart rate and respiratory rate. It is uncertain if TENS plus analgesia, compared with analgesia, has any effect on pain at six or 24 hours after the intervention or on vital signs or on rescue analgesic requirement **(3).**

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