Over the last two decades the number of caesareans being performed has increased dramatically. High quality postoperative analgesia is important because the new mother has to recover from major intra-abdominal surgery while also caring for her newborn baby. Many options are available but tailoring the method to the individual can be difficult because it has been difficult to predict the severity of postoperative pain or the individual response to a regimen. Recent research may allow improved prediction of pain and analgesic needs; important predictive factors include maternal expectations, anxiety and surgical duration. Some of these predictors may be quantifiable ‘at the bedside’ or be amenable to modulation. While acute post-caesarean pain has been widely studied, persisting pain after caesarean delivery has not.

Nikolajsen et al found that 12% of women were still complaining of pain after 10 months and 6% had pain that interfered with their quality of life. Post-caesarean pain has at least two components. Somatic pain arising from nociceptors within the abdominal wound has both cutaneous and deep components. It is transmitted within the anterior divisions of the spinal segmental nerves, usually T10-L1, which run laterally in the abdominal wall between the layers of the transversus abdominis and internal oblique muscles. Visceral uterine nociceptive stimuli return via afferent nerve fibres that ascend through the inferior hypogastric plexus and enter the spinal cord via the T10-L1 spinal nerves.

Various factors can influence the choice of analgesic regimen, such as patient preferences and expectations, expected surgical difficulty and duration, and preference and experience of the anaesthetist. A caesarean may be performed under spinal, epidural or general anaesthesia such that some methods of pain relief are not universally suitable. A hospital may be unable to provide certain methods because of issues related to staff education, training, workload or drug availability. Some methods are contraindicated in certain obstetric situations such as patient refusal, pre-eclampsia, bleeding diathesis and local infection. Consequently, the number of post-caesarean analgesic options continues to expand whilst existing methods are refined.
An ideal post-caesarean analgesic regimen would be one that was cost-effective, simple to implement and with minimal impact on staff workload. It would provide consistent and high quality pain relief while catering for wide interpatient variability but have a low incidence of side-effects and complications. It would not interfere with the maternal care of the newborn or with the establishment of breastfeeding and there would be minimal drug transfer into breast milk and no adverse effects on the newborn. In this regard, a multimodal approach based on opioids is commonly recommended\(^{11,14}\). In this review we evaluate the various options available, emphasising differences between the routes of administration of opioid and non-opioid analgesics, and the abdominal wall nerve blocks, while highlighting new research.

NEURAXIAL TECHNIQUES

Regional anaesthesia has well-documented benefits over general anaesthesia, particularly with respect to maternal safety\(^{15,16}\), and provides the anaesthetist with an effective and convenient route of opioid administration. Neuraxial opioids differ primarily in their potency, onset, duration of action and side-effects\(^{17,18}\). In addition, a limited number of other analgesic drugs may also be utilised through intrathecal or epidural administration.

INTRATHECAL OPIOIDS

Opioids, especially morphine, are central to many intrathecal-based analgesic regimens and act principally on mu-opioid receptors in the substantia gelatinosa of the dorsal horn. While intrathecal fentanyl and sufentanil are both widely given for their intraoperative analgesic effect, unless used in high doses (e.g. fentanyl 40 to 60 µg) their effects are too short-lived to be of benefit postoperatively and they do not alter 24-hour opioid consumption\(^{19,20}\). Their short analgesic duration of action contrasts with the long duration from morphine which is due to the latter's low lipid solubility, such that it takes longer to penetrate neural tissues\(^{17}\). The comparatively lower lipid solubility of morphine delays its onset of action and prolongs its duration of action. Moreover, the longer residence time of morphine in the cerebrospinal fluid allows it to spread rostrally, from which complications such as respiratory depression may arise.

Intrathecal morphine

Many doses of intrathecal morphine have been investigated and at doses above 100 µg no clear dose-response relationship has been demonstrated. Palmer et al studied doses between 0 and 500 µg in 108 women undergoing elective caesarean delivery and found a ceiling analgesic effect, as measured by patient-controlled intravenous morphine use, with doses of morphine above 75 µg\(^{21}\) (Figure 1). Higher doses conferred no additional analgesic benefit but caused a dose-dependent increase in side-effects, particularly pruritus (Figure 2). Palmer et al also noted that despite high doses of intrathecal morphine, most parturients continued to administer

\[\text{Mean 24 hour PCA morphine use (mg)}\]

\[\text{Intrathecal morphine dose (mg)}\]

\[\text{24 hour pruritus score (mean ± SD)}\]

\[\text{Intrathecal morphine dose (mg)}\]

**Figure 1:** Mean (95% CI) 24 hour patient-controlled morphine use with increasing doses of intrathecal morphine demonstrating continued use of intravenous morphine even at high doses of intrathecal morphine. *P <0.05. From: Palmer et al. Anesthesiology 1999; 90:437-444.

**Figure 2:** Mean 24 hour pruritus scores (mean ± SD) demonstrating increased incidence of pruritus with increasing dose of intrathecal morphine. Scores are a cumulative score over 24 hours (scored none=0, mild=1, moderate/severe=2; total out of 21). From: Palmer et al. Anesthesiology 1999; 90:437-444.
additional opioid analgesia at a low but constant rate, possibly explained by an interaction between spinal and supraspinal sites of action. Other studies support a dose of no more than 100 µg as optimal, and smaller doses (25 to 50 µg) combined with a systemic non-steroidal anti-inflammatory drug can be effective\[^2\]. Nevertheless, a dose of 100 µg of intrathecal morphine is unsatisfactory in a small but significant percentage of women. Swart et al demonstrated that after intrathecal morphine 100 µg, most parturients used less than 10 mg of intravenous morphine in the first 24 hours but 10% used more than 40 mg, indicating that intrathecal morphine was relatively ineffective in these women\[^3\].

Intrathecal and epidural morphine share a similar side-effect profile, with pruritus the most common side-effect and others which include nausea, vomiting, reactivation of oral herpetic simplex, urinary retention and delayed respiratory depression\[^24\]. From intrathecal morphine 50 to 250 µg the number needed to harm one individual is 2.6 (95% confidence interval [CI] 2.1 to 3.3) for pruritus, 6.3 (95% CI 4.2 to 12.5) for nausea and 10.1 (95% CI 5.7 to 41.0) for vomiting\[^4\]. If a 100 µg dose is used, it is estimated that 43% of women will experience pruritus, 12% vomiting and 10% nausea\[^5\]. Neuraxial morphine administration has also been linked to the reactivation of oral herpetic simplex. In a study of women with a past history of oral herpetic simplex, reactivation occurred in 38% receiving intrathecal morphine compared with 16% of those receiving intravenous morphine\[^6\]. Respiratory depression is an uncommon and potentially serious side-effect but the incidence in the obstetric population is difficult to determine. Pooled data from a meta-analysis that included 485 patients showed only one case of respiratory depression, as defined by a respiratory rate of less than 10 breaths per minute\[^7\]. Abouleish et al studied 856 parturients who received 200 µg of intrathecal morphine at caesarean and found respiratory depression, as defined by a SpO\(_2\) < 85% or a respiratory rate of <10 breaths per minute, in eight patients (0.93%), all of whom were obese\[^8\]. The physiological changes of pregnancy, specifically the higher respiratory rate associated with elevated progesterone levels, may provide a greater margin of safety in comparison to other patient populations.

**Intrathecal diamorphine**

Diamorphine, in a dose of between 250 to 375 µg\[^9\], is a suitable alternative to intrathecal morphine. It is particularly popular in the United Kingdom, where it is more commonly used than intrathecal morphine for post-caesarean analgesia\[^10\]. Being more lipophilic, diamorphine has a faster onset of action and despite a short half-life in cerebrospinal fluid, once it has diffused into neural tissues it is metabolised into its active components, 6-acetylmorphine and morphine, thus increasing its duration of action\[^11\]. Consequently diamorphine is attractive in providing both intra- and prolonged postoperative analgesia, its intraoperative analgesia being of similar quality to intrathecal fentanyl\[^12\]. Side-effects are dose-dependent, with pruritus and nausea common, occurring in 90% and 30 to 50% of women respectively after a 200 µg dose at caesarean delivery\[^13\].

**Epidural opioids**

There are several approaches to epidural opioid delivery for post-caesarean analgesia. Morphine's low lipid solubility and prolonged duration of action means that a single bolus dose is often satisfactory for the first 24 hours. Fentanyl and pethidine are more lipid soluble and thus have a short duration of action, making them better suited to patient- or nurse-controlled techniques. The predominant site of action may vary with the administration route and dose and both spinal cord and supraspinal sites of action may coincide\[^14\]. For example, although epidural morphine has a predominantly spinal site of action, interactions with supraspinal receptors may also be important for optimal analgesia\[^15\].

**Epidural morphine**

Like intrathecal morphine, a single dose of epidural morphine appears to reach a ceiling analgesic effect. In terms of analgesic quality and supplemental 24-hour morphine consumption, epidural morphine 3 mg appears equivalent to intrathecal morphine 100 µg and usually provides effective analgesia for 12 to 24 hours. Palmer et al studied epidural morphine 0 to 5 mg and found no difference in cumulative systemic morphine use for doses above 3.75 mg\[^16\] (Figures 3 and 4). Patients receiving the higher doses of epidural morphine continued to request additional opioid, lending further support to the theory of the importance of both spinal and supraspinal opioid receptor occupation.

There are few studies comparing epidural and intrathecal morphine. Sarvela et al compared epidural morphine 3 mg with intrathecal morphine 100 or 200 µg\[^17\]. Pain relief did not differ significantly between groups but rescue analgesia was requested more frequently in the 100 µg intrathecal morphine group (Figures 5 and 6), which experienced less
pruritus (65% vs 91% in the 100 µg and 200 µg groups respectively and 74% in the epidural group) (Figure 5).

Epidural diamorphine

Like intrathecal diamorphine, epidural diamorphine 2 to 3 mg is popular for post-caesarean analgesia in the United Kingdom. Bloor et al audited 188 women receiving these doses and found that 92% had pain rated as mild or less\(^{36}\). The same investigators compared epidural diamorphine 3 mg to intrathecal diamorphine 300 µg and found similar quality analgesia but a higher incidence and severity of pruritus in the intrathecal group (33% moderate to severe pruritus vs 3% in the epidural group)\(^{36}\). Compared with intrathecal morphine (200 µg), epidural diamorphine 3 mg has a shorter duration of action (time to first supplementary analgesia request of 22.3±12.0 hours vs 13.8±6.5 hours, \(P=0.04\)) but a lower incidence of nausea and vomiting (73% vs 41%, \(P=0.01\))\(^{36}\).

Epidural pethidine

Patient-controlled epidural pethidine is used in a number of countries with one validated regimen being a 20 mg bolus and 15 minute lockout administered via a lightweight, single-use device\(^{38}\). Intrathecal morphine 200 µg results in lower pain scores in the first 12 postoperative hours but with more pruritus (33% vs 5% with patient-controlled epidural pethidine, \(P <0.001\)) and a higher incidence of nausea requiring treatment (50% vs 8% with patient-controlled epidural pethidine, \(P <0.001\))\(^{39}\). When compared to intravenous pethidine in a double-blind, crossover trial, epidural pethidine produced significantly lower pain scores (\(P=0.0001\))

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**Figure 3**: Cumulative patient-controlled morphine use (mean and 95% CI) over 24 hours with increasing doses of epidural morphine demonstrating a ceiling effect in analgesia with a dose greater than 3.75 mg. From: Palmer CM et al. Anesth Analg 2000; 90:887-891.

**Figure 4**: Dose-response curve predicting patient-controlled morphine use (mean 95% CI) after different doses of epidural morphine. From: Palmer CM et al. Anesth Analg 2000; 90:887-891.
analgesia after caesarean delivery

Figure 5: Percentage of patients with itching and PONV and those requesting treatment with epidural (3 mg) and intrathecal (100 and 200 µg) morphine. Patients in the 100 µg IT morphine group had less itching, required less interventions for itching but required more rescue analgesia. From: Sarvela et al. Anesth Analg 2002; 95:436-440.

Figure 6: Visual analogue scale (VAS) scores of postoperative pain (mean and 95% CI) during the first 24 hours with epidural versus intrathecal morphine. * P < 0.05. From: Sarvela et al. Anesth Analg 2002; 95:436-440.

(Figure 7), lower sedation scores (P=0.0001) and improved patient satisfaction (P=0.0001), such that more than 90% of women preferred the epidural route of administration.

Epidural fentanyl

Epidural fentanyl is widely used during labour and delivery and for non-obstetric postoperative analgesia but there is a paucity of published work describing its use for post-caesarean analgesia. When compared to epidural pethidine, Goh et al showed comparable patient-controlled analgesia but higher patient satisfaction and preference for epidural pethidine. Ngan Kee et al noted a similar patient preference for epidural pethidine over intravenous pethidine, although this was not the case for fentanyl. Cooper et al found improved analgesia (median pain scores with movement 31 mm [inter-quartile range 21 to 41] vs 56 mm [30 to 71]) from patient-controlled epidural fentanyl than from intravenous morphine, with less nausea and drowsiness.

The cumulative dose of epidural fentanyl can be reduced by the addition of bupivacaine or adrenaline but this has uncertain clinical benefit after
caesarean delivery and introduces the possibility of local anaesthetic-induced complications, such as impaired ambulation and pressure sores. Cooper et al observed that the addition of bupivacaine 0.05% to epidural fentanyl 2 µg/ml reduced fentanyl consumption by 57% but did not change patient satisfaction or lead to other clinical benefits. In contrast, Cohen et al showed that the addition of small amounts of bupivacaine (0.01%) or adrenaline (0.5 µg/ml) to epidural fentanyl not only decreased overall fentanyl consumption but also improved analgesia and satisfaction while reducing side-effects.

Epidural sufentanil

Epidural sufentanil has similar clinical characteristics to fentanyl in regard to onset and duration, with a relative analgesic potency to fentanyl of approximately 5:1. Cohen et al compared epidural sufentanil and fentanyl (with bupivacaine and adrenaline) by background infusion and patient demand bolus, reporting more vomiting (12% vs 4.8%) and dizziness/lightheadedness in the sufentanil group. This, together with the lack of any clear advantage over other neuraxial opioids, has probably limited its popularity for post-caesarean analgesia.

Extended release epidural morphine

A new formulation of morphine in which the morphine is encapsulated in lipid foam particles has been developed for epidural use. The encapsulation of the water-soluble morphine slows release resulting in prolonged drug delivery and a dose-dependent half life. The few clinical studies to date show analgesia extending into the second postoperative day and no significant side-effects. When extended release epidural morphine 5, 10 or 15 mg was compared to a standard 5 mg dose of epidural morphine sulphate, the supplemental opioid dose used during the 24 to 48 hours postoperatively was significantly decreased in the 10 and 15 mg groups (25±21 mg vs 47±34 mg in the 10 mg extended release and 5 mg standard group respectively). Area under the curve analysis across the first 48 hours showed less pain in the 10 and 15 mg groups. A comparison of 10 mg extended release epidural morphine and a 4 mg standard epidural morphine dose reported a significant reduction in 48-hour opioid use, although this appeared clinically unimportant (10±17 mg morphine equivalents vs 17±22 mg, P=0.037). However, pain relief was better after 24 hours without an increase in side-effects. The prolonged effect into the period of full patient activity is attractive, but as the lipofoam may become unstable in the presence of local anaesthetic, its safety for women who have had epidural analgesia during labour is not yet known. The formulation is expensive and it will be difficult for many institutions to justify the additional cost when cheaper alternatives are available for analgesia on the second postoperative day.

NEURAXIAL ADJUNCTS

A number of non-opioid analgesics have been used in conjunction with epidural and intrathecal opioids to optimise postoperative analgesia. Of these agents clonidine, an α₂ adrenergic receptor agonist, has been the most widely studied.
actions are enhanced by pregnancy and it appears to be particularly effective for visceral pain. In obstetric patients intrathecal clonidine slows the regression of the sensory block after spinal anaesthesia, delaying the onset of postoperative pain (Figure 8). Clonidine alone, in doses up to 150 µg, does not provide sufficient postoperative pain relief, so must be combined with neuraxial morphine or other techniques. With intrathecal morphine, clonidine 30 to 60 µg decreases overall opioid requirement and increases the duration of analgesia, but increases intraoperative sedation. Epidural clonidine 75 to 150 µg has similar sedative effects. When combined with a modest dose of epidural morphine (2 mg) analgesia was prolonged from 6.3 hours (control) to 13.3 hours (75 µg) and 21.5 hours (150 µg).

Neuraxial neostigmine, by inhibiting acetylcholinesterase and preventing the breakdown of acetylcholine in the spinal cord interneurones, provides effective analgesia with no motor or sympathetic blockade. When administered intrathecally it causes severe nausea and vomiting (74% incidence after with a 25 µg dose) which precludes its use by this route. In contrast, epidural neostigmine is not associated with an increased risk of postoperative nausea and vomiting and 75 to 300 µg doses result in modest analgesia in women post-caesarean (global pain scores 3.0 to 3.5±0.3 in the neostigmine groups vs 5.4±0.2 in the placebo group). Higher doses of neostigmine increase sedation but do not appear to increase nausea and vomiting. More studies in obstetric patients are required to validate these results and to ascertain whether there is a benefit from adding neostigmine to epidural solutions for post-caesarean analgesia.

**INTRAVENOUS, INTRAMUSCULAR AND SUBCUTANEOUS OPIOIDS**

Patient-controlled intravenous opioids are popular after caesarean delivery because of convenience, safety and consistently high patient satisfaction. In comparison with neuraxial opioids, it appears that intravenous opioids provide inferior pain relief but they are often rated favourably in terms of patient satisfaction, most likely due to the increased autonomy that comes with a patient-controlled technique. This is demonstrated when patient-controlled neuraxial and intravenous opioid delivery is directly compared; in this situation neuraxial opioids are more likely to be preferred. Morphine is popular for intravenous patient-controlled analgesia in obstetrics and is often used as a standard against which other interventions are evaluated. Fentanyl is also an appropriate systemic opioid, in contrast to pethidine, which is rarely used due to accumulation of its active metabolite in breastmilk and adverse effects on the newborn. The combination of alfentanil and morphine may also hold advantages, especially in relation to speed of onset.
Patient-controlled intravenous or neuraxial techniques have a number of advantages. These include catering for the wide interpatient variation in analgesic requirements and reducing staff workload. More stable plasma drug concentrations are likely to result in more reliable pain relief than that associated with nurse-administered techniques, although higher concentrations may increase the incidence of opioid-related side-effects. Patient mobilisation may be restricted unless a lightweight, portable device is used. The potential for device malfunctions and programming errors can also lead to adverse patient outcomes.

At least one previous review has suggested that intramuscular and subcutaneous opioids are the most commonly used methods of post-caesarean pain relief although evidence for this is lacking. While being cheap and simple to administer, they have a number of disadvantages. Blood levels of opioid are likely to vary considerably between individuals, the injection may be painful, the method labour intensive and women reluctant to request further doses. These methods are rarely used in clinical studies and poorly reported in the literature.

**ORAL OPIOIDS**

Oral opioids have traditionally been used as ‘step-down’ analgesics after primary management with neuraxial or intravenous opioids. The advantages of the oral route include simplicity and convenience for both patients and staff and potentially fewer side-effects compared with the intravenous or neuraxial route. Oral opioid regimens should provide early fixed interval dosing with additional ‘on-demand’ dosing. Oxycodone, a mu-opioid receptor agonist, is an example of an oral opioid that is available in a number of formulations and it appears to be gaining popularity for post-caesarean pain. Our department has recently completed a study comparing intrathecal morphine with regular oral oxycodone (commenced in the recovery room) after spinal anaesthesia for caesarean birth. The oral multi-modal approach was feasible and acceptable to most women. The time to first analgesic request and the 24-hour cumulative pain scores were similar between groups, while there was significantly less pruritus but lower maternal satisfaction (median score 8, interquartile range 8 to 10 vs 10, interquartile range 7 to 10, P=0.01) (Figure 9) in the oxycodone group. Data on the use of oral morphine is currently limited, experience to date appears positive, although it is yet to be the subject of a formal randomised trial.

Tramadol, an analgesic with weak mu-opioid receptor agonism and activity at noradrenergic, serotonergic and GABAergic systems, is another alternative parenteral or oral analgesic for post-caesarean pain. Despite being used in breastfeeding mothers for a considerable period of time, data on breast milk transfer for oxycodone and tramadol were limited until recent research showing both oxycodone and tramadol transfer is below that considered clinically significant for the neonate.

**NON-STEROIDAL ANTI-INFLAMMATORY DRUGS**

Non-steroidal anti-inflammatory analgesics (NSAIDs) are particularly effective against the visceral pain that arises from the uterine incision and uterine involution following caesarean delivery. They have a well-documented opioid-sparing effect, with a consequent reduction in opioid-related side-effects. Dahl et al investigated rectal diclofenac, 100 mg bd, and found a reduction in the postoperative morphine consumption from 21.5 mg to 14.0 mg in the first 32 hours. Cardoso et al combined intramuscular diclofenac with intrathecal morphine and supplemental analgesia was avoided, even at intrathecal morphine doses of 25 µg. Pavy et al demonstrated a 30% opioid-sparing effect from intravenous ketorolac 120 mg over 24 hours, but ketorolac now has a Food and Drug Administration ‘black box’ warning for obstetric use because of concerns about the effect of fetal and neonatal exposure. When Pavy et al compared rectal indomethacin (100 mg bd) with placebo in conjunction with intrathecal morphine, median time

![Figure 9](https://example.com/figure9.png)

*Figure 9: Area under the curve for pain scores and sedation (median, interquartile range, 10th and 90th percentiles) with oral oxycodone versus intrathecal morphine. From: McDonnell NJ, Paech MJ, Browning RM, Nathan EA. Int J Obstet Anesth (in press, accepted December 2008).*
to first analgesia was extended from nine hours in the control group to 39.5 hours in the indomethacin group ($P < 0.003$) with enhanced pain relief with movement (mean VAS scores 1.4 vs 5.1, $P < 0.001$).

Traditional NSAIDs have well-documented effects on platelet, renal and gastrointestinal function and are relatively contraindicated in the postpartum period in women suffering from pre-eclampsia, secondary to their potential to worsen hypertension, precipitate a hypertensive crisis or compromise renal blood flow. Concern has also been raised in regard to uterine atony in the postpartum period in women suffering from pre-eclampsia, with case reports of severe uterine atony associated with ketorolac. Although there is insufficient evidence for a causal relationship, the use of NSAIDs in women at risk of postpartum haemorrhage deserves consideration.

The introduction of the cyclo-oxygenase 2 (COX 2) specific inhibitors has the potential to decrease side-effects, particularly in regard to the platelet and gastrointestinal systems, but research in obstetrics is very limited. Carvalho et al studied valdecoxib post-caesarean but the study was stopped early secondary to emerging safety concerns about the COX 2 agents. No difference from placebo was seen for time to first analgesia or total opioid use (143 mg morphine equivalents in the placebo group vs 121 mg in the valdecoxib group). There is also no current information about the safety of the COX 2 agents in breastfeeding women.

**PARACETAMOL**

Paracetamol may also work through central COX 2 inhibition, with a reduction in central nervous system prostaglandin E2 production and activation of descending serotonergic pathways. Studies in the obstetric population are few and have reported conflicting results. Alhashemi et al compared intravenous paracetamol 1 g with oral ibuprofen 400 mg post-caesarean and found no difference in 48-hour morphine consumption (98±37 and 93±33 mg for paracetamol and ibuprofen respectively). Siddik et al found a significant morphine-sparing effect with rectal diclofenac but not intravenous propacetamol and no additional benefit when both were combined. In contrast, Munishankar et al demonstrated that the combination of paracetamol and diclofenac resulted in significantly less morphine consumption than paracetamol alone (33.8 mg vs 54.5 mg). Despite these conflicting results, there is little risk associated with paracetamol therapy and it has been suggested as ‘near-routine’ for postoperative pain management. The release of intravenous paracetamol may offer advantages, particularly for early postoperative analgesia and patient acceptance in comparison with rectal administration.

**WOUND INFILTRATION AND NERVE BLOCKS**

A significant component of the pain experienced after caesarean delivery arises from the surgical incision through the anterior abdominal wall. This can be blocked with a number of local anaesthetic techniques, including ilioinguinal and iliohypogastric nerve blocks, wound instillation and most recently, the transversus abdominis plane (TAP) block. The potential advantages of these techniques are that they are less invasive than neuraxial blocks, are suitable for patients having general anaesthesia and can also be repeated postoperatively if required.

Despite evidence of efficacy, ilioinguinal/iliohypogastric nerve blocks do not appear to be widely used, possibly because of high rates of block failure (up to 50% in some studies) and a relatively short duration of action. A continuous technique, using ultrasound guidance and continued via a catheter for 72 hours postoperatively has recently been described with excellent results. As this was a small case series of only three patients, the encouraging results require further investigation.

Wound infusion catheters are used in a number of postoperative settings but results after abdominal surgery have been mixed. This is probably due to differences in the site of catheter placement, drugs used and the outcome with continuous versus bolus techniques. Ranta et al, in a double-blind study, compared epidural analgesia and subfascial wound catheters using an intermittent bolus technique. Pain scores in the epidural group were lower at the four hour mark after which both groups had pain scores of 3 or less. Fredman et al investigated a patient-controlled elastomeric wound infusion device (0.2% ropivacaine 10 ml hourly on request) in a placebo-controlled trial and found decreased pain with movement and lower opioid requirements in the intervention group. In contrast, Zohar et al found no benefit from regular intermittent bolus dosing of bupivacaine into the surgical wound via an epidural catheter placed at the conclusion of surgery.

Interestingly, diclofenac (300 mg over 48 hours) via a wound infusion catheter decreases 48 hour morphine requirements compared with ropivacaine infusion or intravenous diclofenac (18 mg [95% CI 12.7 to 22.2] in the diclofenac wound infusion group compared with 28 mg [95% CI 18.2 to 32] in the ropivacaine/intravenous diclofenac group and 38 mg [95% CI 28.8 to 43.7] in the saline/intravenous

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diclofenac group). This raises the possibility that diclofenac has peripheral analgesic properties. While wound infusion catheters provide prolonged drug delivery, the optimal placement site is unknown. The relatively high cost of some disposable devices and the effort required in preparation and insertion may have limited their widespread acceptance.

The TAP block is a newly described technique for blocking the neural afferents to the anterior abdominal wall. In this block, local anaesthetic is injected into the neurofascial plane between the internal oblique and the transversus abdominis muscles. The surface landmarks are relatively consistent between individuals and the passage through the tough fascia of the abdominal wall muscles provides a definitive endpoint, which can also be visualised using ultrasound. McDonnell et al evaluated 50 women with a Pfannenstiel incision and randomised them to a bilateral TAP block using ropivacaine 0.75% (1.5 mg/kg to a maximum of 150 mg per side) or a saline placebo. The median time to first morphine request was extended from 90 to 220 minutes in the TAP group. The TAP group also had lower morphine requirements in the first 48 hours (18 mg vs 66 mg, \( P < 0.001 \)) (Figure 10) and a corresponding reduction in sedation and nausea. These initial results are encouraging, but because the blocks were performed by a single experienced operator, further research is required to ascertain whether these findings are reproducible in other centres.

**CONCLUSION**

High quality pain relief is important after caesarean delivery to promote early recovery and optimise the mother’s ability to care for her newborn. Currently opioids form the foundation of post-caesarean analgesia, with patient-controlled techniques being preferred by mothers. Neuraxial opioids have a favourable efficacy and side-effect profile compared with intravenous techniques. The clinical differences between neuraxial opioid drugs relate mainly to duration of action and dose-dependent side-effects, but the choice of opioid is also subject to local and resource considerations. Neuraxial clonidine (and possibly epidural neostigmine) enhance postoperative analgesia with few untoward effects apart from sedation, but do not appear to be frequently employed. In addition to opioids, NSAIDs and paracetamol add further benefit but are not always appropriate. Local anaesthetic blocks may be of benefit but are associated with a high failure rate, which may improve with the introduction of ultrasound imaging and the success of the TAP block requires imaging and the success of the TAP block requires...
further validation. A multimodal approach is recommended whenever possible and future research should focus not only on acute, but also chronic, post-caesarean pain.

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