

# Pain relief after transversus abdominis plane block for abdominal surgery in children: a service evaluation

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**Abstract:** We carried out a prospective service evaluation of the quality of pain control after preoperative transverse abdominis plane (TAP) block in 100 children undergoing abdominal surgery. Data were collected on type of procedure, age, weight, level of the block, local anesthetic used, additional analgesia, and hourly pain scores. Of the 100 patients, 87 were included in the evaluation, 77% of who were less than 1 year old. Adequate pain relief was achieved in 93% of all patients. Almost half (47%) of our patients did not require intravenous (IV) opioids in the postoperative period and 27% did not need any IV opioids at all. Our results confirm the good quality of perioperative analgesia achieved with a TAP block as part of a multimodal approach in children undergoing abdominal surgery. Depending on the patient's age and the type of procedure, a TAP block may eliminate the need for IV opioids.

**Keywords:** intravenous opioids, pain control, TAP block, perioperative analgesia, postoperative analgesia

## Introduction

Despite a rise in abdominal surgical activity at our institution (Birmingham Children's Hospital, Birmingham, UK) the use of epidural analgesia has fallen by more than 50% over the past 5 years. Among other factors this is due to the introduction of new regional anesthesia techniques such as the ultrasound-guided transversus abdominis plane (TAP) block.<sup>1</sup> Recent studies suggest that the TAP block is an effective regional technique for perioperative analgesia in abdominal surgery, but there is little supporting evidence of this in children.<sup>2-5</sup> In order to assess our own practice we evaluated the quality of postoperative analgesia in children who had received a preoperative TAP block for abdominal surgery.

## Methods

We carried out a prospective service evaluation on the quality of pain control after preoperative TAP block in 100 children undergoing abdominal surgery. Prospective service evaluations are well-established quality assessment instruments in the UK's National Health Service. This study was approved and registered with Birmingham Children's Hospital's clinical governance department (reg. BCHAN 86/2010) and conducted as a prospective evaluation of practice and outcome in line with UK legislation. The results were anonymized and do not allow identification of individual patients. The hospital's clinical governance department advised that publication of the results does not require patient or parental consent.

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Data collection commenced in January 2011 and continued until January 2013. Data were collected on type of procedure, age, weight, type of TAP block (subcostal vs lateral, additional rectus sheath block), type and volume of local anesthetic used, intra- and postoperative analgesia given, complications, and hourly pain scores up to 48 hours post-surgery using age-appropriate and validated tools (ie, the Neonatal and Infant Pain Scale [NIPS] in children up to 3 months old, the Face, Legs, Activity, Consolability Scale [FLACC] in children up to 6 years old, and self reporting scores [Wong Baker Scale] in older children).<sup>6,7</sup> Pain scoring in the perioperative period is mandatory at our institution and part of the hourly vital-function assessment after surgery. All patients included were followed up for at least 48 hours and visited once a day by a member of the pain service to monitor the quality of the data recorded and to ensure that opioids were not withheld if indicated.

Patients with pre-existing chronic pain conditions were excluded from the study. Patients who received their TAP blocks after surgery were also excluded because such patients often recover from anesthesia before the TAP block is fully working and require intravenous (IV) opioids in the immediate postoperative period.

## Results

### Patients

We collected data on 100 patients. Of these, 13 were excluded; eight patients because of insufficient data and five because of violation of the exclusion criteria. A total of 87 patients were included in the study. Sixty-seven patients (77%) were less than 1 year old (Table 1). In terms of weight, 25 patients weighed 3 kg or less, 22 patients weighed between 3 and 5 kg, and 40 patients weighed more than 5 kg.

### Techniques applied

TAP blocks were placed after induction of general anesthesia and before the start of surgery. The transverse abdominal plane was identified using a “hockey stick” ultrasound probe (SLA 25) or a linear ultrasound probe (HFL38) in older children. A 21-gauge hypodermic needle was used to inject the local anesthetic under real-time ultrasound imaging. The level of the block was tailored to the area of analgesia required by the surgical incision:

1. for upper-abdominal surgery the subcostal approach with hydro-dissection (73 patients) was followed as described by Hebbard<sup>8</sup>
2. for lower abdominal surgery, the TAP block was sited more laterally (14 patients)<sup>9,10</sup>

**Table 1** Number of patients and types of surgical procedures carried out in the different age groups. The procedures cover a wide spectrum of pediatric surgery

Age group	Patients, N	Procedures*
Neonates	33	Formation of stoma (9), intestinal atresia (7), malrotation (5), gastroschisis closure (4), intestinal obstruction (3), stoma revision (2), other procedures (3)
Infants	34	Stoma closure (10), Kasai procedure (7), intussusception (5) malrotation (3), cholangiogram (2), other procedures (7)
1–3-year-olds	9	Malrotation (2), stoma closure (3), cholecystectomy (1), open fundoplication, (1) Mitrofanoff procedure (1), vesicostomy (1)
4–8-year-olds	7	Mitrofanoff procedure (2), bladder augmentation (1), intussusception (1), appendectomy (1), ureter reimplantation (1), insertion of pelvic spacer (1)
9–18-year-olds	4	Removal of ovarian tumor (2), adhesiolysis ± stoma formation (1), removal of peritoneal dialysis catheter (1)

**Note:** \*Values in parentheses indicate number of patients.

3. analgesia was supplemented with a contra-lateral rectus sheath block for incisions reaching the midline (ten patients)
4. for incisions crossing the midline a bilateral TAP block was sited (15 patients).

### Local anesthetic

Levobupivacaine was used in all patients. A total of 43 patients received 1 mL·kg<sup>-1</sup> of 0.25%, 28 received 2 mL·kg<sup>-1</sup> of 0.125%, and 16 received levobupivacaine in different concentrations and volumes never exceeding a dose of 2.5 mg·kg<sup>-1</sup>.

### Surgical procedures

The surgical procedures are listed in Table 1.

### Perioperative analgesia and opioid consumption

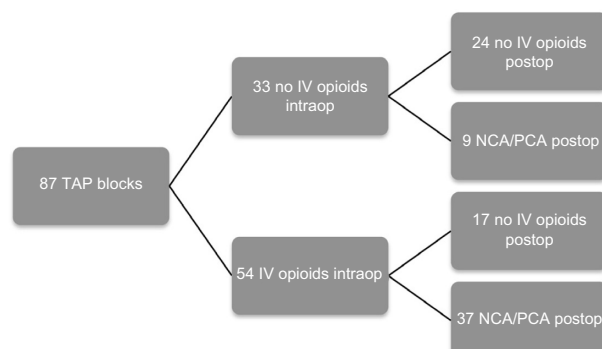
Fifty-four patients (62%) received IV opioids during surgery. The use of opioids during the procedure was at the discretion of the anesthetist. Some anesthetists administered opioids preemptively but in the majority of cases the decision was based on the cardiovascular response to stimulation; a heart rate increase of 10% from baseline was usually interpreted as insufficient analgesia and was treated

with opioids. Patients were given either fentanyl in doses of 1–4 mcg·kg<sup>-1</sup> (31 patients), remifentanyl as continuous infusion 0.01–0.10 mcg·kg<sup>-1</sup>·min<sup>-1</sup> (four patients), morphine up to 100 mcg·kg<sup>-1</sup> (13 patients) or a combination of these (six patients). Thirty-three patients (40%) did not require IV opioids during surgery (Figure 1).

According to the hospital's pain protocol all patients received paracetamol 6-hourly postoperatively combined with ibuprofen and/or codeine if the pain score exceeded 3. A total of 46 patients (53%) received morphine via nurse-controlled analgesia (NCA) or patient-controlled analgesia (PCA) while the remaining 41 patients did not receive IV opioids. The prescription of postoperative NCA/PCA was also at the discretion of the anesthetist. Children under the age of 6 years old received morphine via NCA continuously at a rate of 10 mcg·kg<sup>-1</sup>·h<sup>-1</sup> with a bolus option of 10–20 mcg·kg<sup>-1</sup> every 20 minutes and older children received morphine via PCA continuously at a rate of 4 mcg·kg<sup>-1</sup>·h<sup>-1</sup> with a bolus option of 20 mcg·kg<sup>-1</sup> every 5 minutes. Neonates received Morphine via NCA at a rate of 4 mcg·kg<sup>-1</sup>·h<sup>-1</sup> and a bolus option of 10 mcg·kg<sup>-1</sup> every 20 minutes. Four children did not receive maintenance but had a bolus option only.

Twenty-four patients did not receive any IV opioids during or after the procedure (Figure 1). Table 2 delineates the age groups and procedures for this subgroup. The hourly pain assessment assured that opioids were not withheld from our patients if they were indicated.

Postoperative IV opioid requirement was related to patient age. Of neonates, 73% did not receive postoperative IV opioids, whereas in the 9–18-year-old group only 25% did not receive IV opioids in the postoperative period (Figure 2).



**Figure 1** Breakdown of patients who received additional intravenous (IV) opioids intraoperatively (intraop) and/or postoperatively (postop) after administration of a transversus abdominis plane (TAP) block for abdominal surgery.

**Note:** Of all patients, 47% did not require postoperative IV opioids and 27% didn't need intra- nor postoperative IV opioids despite the extent of surgery.

**Abbreviations:** NCA, nurse-controlled analgesia; PCA, patient-controlled analgesia.

**Table 2** Patients who did not receive any intravenous (IV) opioids by age group and procedure

Age group	Patients, N	Procedure(s)*
Neonates	14	Colostomy (7), intestinal atresia (3), gastroschisis closure (3), stoma reversal (1)
Infants	2	Malrotation (2)
1–3-year-olds	4	Intussusception (3), cholangiography (1)
4–8-year-olds	2	Cholecystectomy (1), vesicostomy (1)
9–18-year-olds	2	Ureter reimplantation (1), removal of peritoneal dialysis catheter (1)

**Notes:** \*Values in parentheses indicate number of patients. More than 25% of all patients did not require IV opioids during surgery or in the postoperative period; these patients were managed with oral or rectal analgesics only.

Morphine consumption in the first 24 hours in the NCA/PCA group ranged from 6.7 mcg·kg<sup>-1</sup>·hr<sup>-1</sup> in neonates to 17 mcg·kg<sup>-1</sup>·hr<sup>-1</sup> in the oldest age group (Figure 3). Morphine requirement declined over 48 hours in all age groups.

## Quality of postoperative pain control

Pain scales (NIPS/FLACC/Wong-Baker) were from 0 to 7, 0 to 10, and 0 to 10 respectively, with 0 reflecting no pain and the maximum scores of 7 and 10 respectively, reflecting unbearable pain. We defined “adequate pain relief” as pain scores of <4 consistently (no intervention required) throughout the observation period. A review of the pain scores demonstrated adequate pain relief in over 93% of all patients. The pain scores were recorded hourly (Figure 4). Six per cent of our patients showed episodes of pain scores >3, which were successfully controlled with enterally administered ibuprofen or codeine in line with the hospital's pain protocol. Only one patient did not show a reduction of pain score to <4 after intervention and required conversion to intravenous morphine per NCA in the ward.

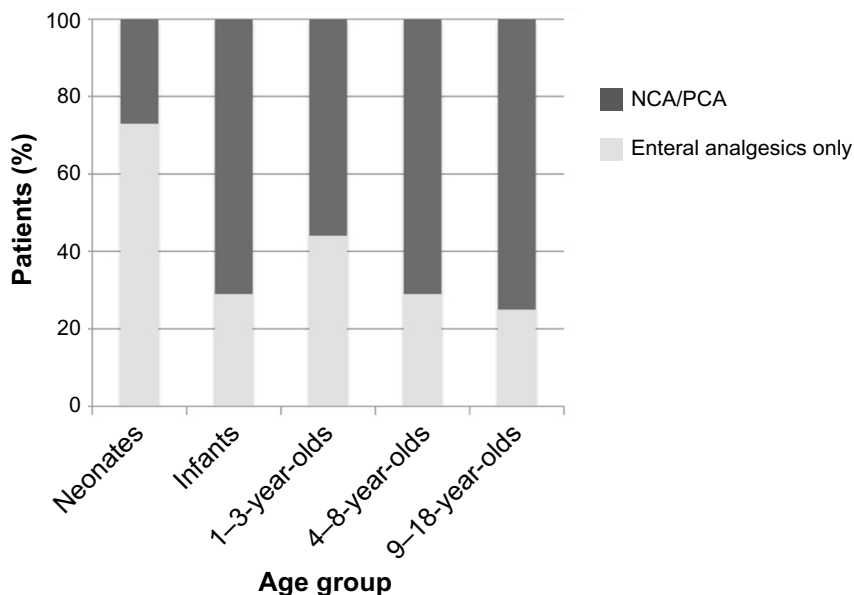
## Complications

No complications of the TAP block were observed during the study.

## Discussion

We carried out this study to assess the quality of pain control in children who received a TAP block for abdominal surgery.

The vast majority (93%) of our patients had adequate pain control (pain scores <4) during the first 48 hours following surgery. Almost half (47%) of the patients did not require IV opioids in the postoperative period and 27% did not receive any IV opioids at all. This is a remarkable finding, as the TAP



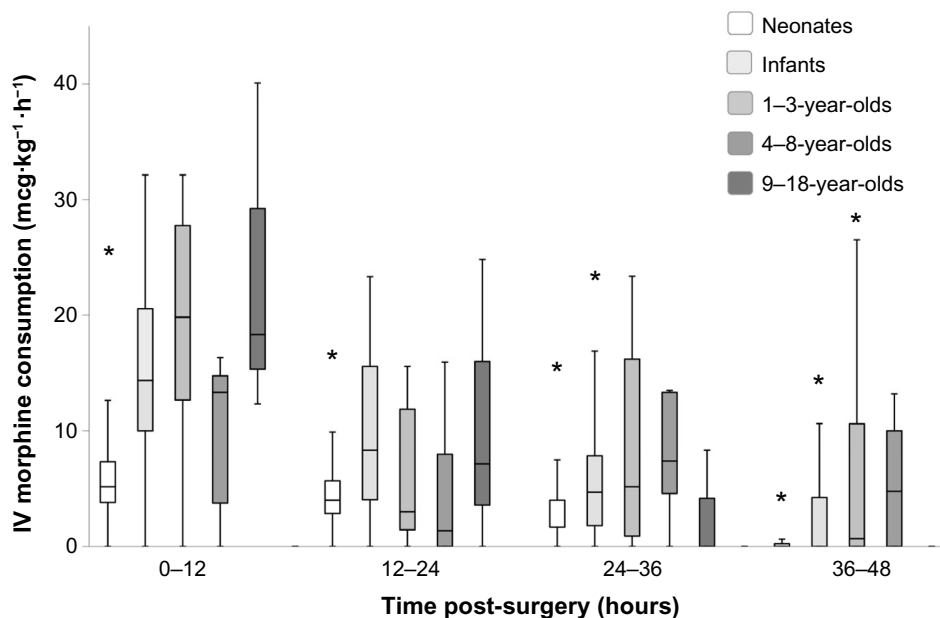
**Figure 2** Patients (%) per age group who received intravenous (IV) opioids via nurse-controlled analgesia (NCA)/patient-controlled analgesia (PCA) in the postoperative period versus patients who were managed on enteral analgesics only.

**Notes:** The vast majority of patients in the neonatal age group did not require postoperative IV opioids. All patients were assessed hourly to assure that IV opioids were not withheld when indicated.

block supposedly only covers the somatic sensation to the abdominal wall and the parietal peritoneum but not visceral pain arising from the intra-abdominal organs. On the other hand, the TAP is in one continuum with the paravertebral space. We assume that the high volumes of local anesthetic that we use ( $1-2 \text{ mL} \cdot \text{kg}^{-1}$ ) facilitate spread into the paravertebral space, resulting in some visceral analgesia. This seems

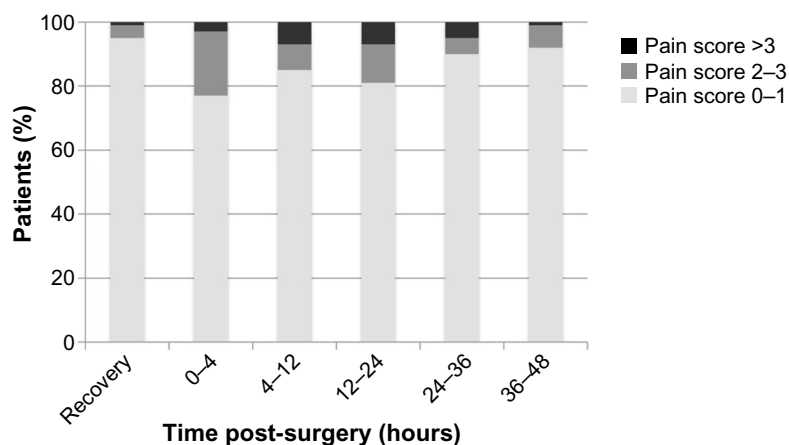
to be pronounced in neonates and small infants, alleviating or even eliminating the need for IV opioids.

Our results indicate that pain seems to be slightly more intense between 12 and 36 hours after surgery, than in the early postoperative period, which could be explained by the TAP block wearing off. By this time pain is usually well controlled with paracetamol and/or ibuprofen and/or codeine.



**Figure 3** Intravenous (IV) morphine consumption via nurse-/patient-controlled analgesia for every age group over the first 48 hours post-surgery. Opioid requirements increased with age and decreased over time in all age groups.

**Notes:** Median, first quartile (Q1), and third quartile (Q3). The ends of the whiskers are set at  $1.5 \cdot \text{interquartile range (IQR)}$  above Q3 and  $1.5 \cdot \text{IQR}$  below Q1. If the minimum or maximum values are outside this range, they are shown as outliers (\*).



**Figure 4** Highest pain scores during the first 48 hours post-surgery.

**Note:** Of our patients, 93% received adequate pain control with hourly measured pain scores consistently <4 not requiring intervention.

Additional IV morphine requirement seems to increase with age. Interestingly additional IV morphine consumption was higher in infants than in 1–4-year-olds. This could be due to difficulties in differentiating pain from other causes of distress in this particular age group.

The number of patients in our sample older than 1 year of age was low (23%). Therefore the results for the older children should be interpreted with caution. As mentioned before, it seems that the additional IV opioid requirement increases with age and the literature shows that the efficacy of a TAP block is less in adults than in children.<sup>11,12</sup>

Howard et al investigated postoperative morphine requirements in 10,000 patients.<sup>13</sup> Unfortunately the results are difficult to compare with ours, as surgical procedures are not specified per age group in that study. However, the average morphine requirements that we found were less than those indicated by Howard et al. The fact that only 47% of our patients needed IV opioids postoperatively despite having undergone major abdominal surgery suggests that a preoperatively sited TAP block indeed reduces opioid requirement. The thorough pain monitoring, as described earlier, rules out under-treatment as a cause of the reduced opioid demand.

Pain relief was adequate in the vast majority of our patients. This was true even in patients receiving large midline-crossing upper-abdominal incisions, who are notoriously difficult to keep comfortable on systemic analgesia alone.

## Limitations

Obviously there are several limitations to our study, which are mainly due to its descriptive nature. First the approach to the TAP block was not standardized, which is reflected in the different doses of local anesthetics used. Second, there was no control group, which makes it difficult to put our

results into perspective. Third there is a certain selection bias because the decision to site a TAP block was at the discretion of the anesthetist and, due to lack of supporting data, mainly based on personal preference. However, we feel that the prospective design and the meticulous data collection contribute to the validity of our findings and compensate for these limitations.

## Conclusion

Our results confirm the good quality of perioperative analgesia achieved with a TAP block as part of a multimodal approach in children undergoing abdominal surgery. Depending on the age of the patient and the type of the procedure, a TAP block may eliminate the need for IV opioids.

## Disclosure

The authors declare no conflicts of interest in this work.

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