Nerve blocks of the anterior abdominal wall

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Key points

Simple peripheral blocks, used in the correct situation, can provide analgesia for a variety of surgical indications and have minimal haemodynamic effects.

The key to understanding nerve blocks of the abdominal wall is an understanding of the anatomy.

These blocks only provide analgesia to the abdominal wall and not the abdominal viscera.

Regional anaesthesia of the abdominal wall has the ability to control pain effectively and allow earlier mobilization.

Ultrasound guidance can assist in localization of tissue planes and aid successful nerve block.

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A significant component of pain experienced after abdominal surgery is related to incision of the abdominal wall and adequate analgesia can be a challenge. Regional blocks of the anterior abdominal wall can significantly help with intraoperative and postoperative analgesia.

In this article, we aim to describe the techniques and applications for abdominal wall nerve blocks, including the ilioinguinal, iliohypogastric, rectus sheath, and transversus abdominis plane (TAP) blocks.

These simple but often overlooked blocks, when used for the appropriate surgical procedure, can provide excellent postoperative analgesia, decrease opioid requirements, allow patients to breathe and cough more comfortably, and facilitate early mobilization and discharge.

Anatomical considerations

The key to understanding nerve blocks of the abdominal wall is an understanding and application of the anatomy.

There are three muscle layers within the abdominal wall, each with an associated fascial sheath. From superficial to deep, these are the external oblique, internal oblique, and transversus abdominis. In addition, the paired rectus abdominis muscle forms a muscle layer either side of the midline (Fig. 1).

The anterior abdominal wall can be described as the area surrounded by the costal margin and xiphoid process of the sternum superiorly, the inguinal ligament and the pelvic bone inferiorly, and laterally, the mid-axillary line.[1]

The skin and fascia of the anterior abdominal wall overlie the four muscles which help support the abdominal contents and the trunk, with the main nerve supply lying in a plane between the internal oblique and transversus abdominis. Beneath the muscles lie extraperitoneal fat and then the parietal peritoneum.

Each muscle layer is surrounded by a fascial plane. The external oblique muscle is the most superficial arising from the middle and lower ribs, with fibres sloping down and forward to the iliac crest, forming an aponeurosis below that level. The internal oblique attaches to the lateral two-thirds of the inguinal ligament and anterior iliac crest with its fibres sloping forwards and upwards. The transversus abdominis muscle is the innermost layer with fibres running transverse towards the midline.

Lying medially is the principal vertical abdominal muscle, the rectus abdominis muscle. This paired muscle is separated in the midline by the linea alba. The rectus abdominis muscle is wide and thin superiorly, increasing in thickness inferiorly. The majority of the rectus abdominis muscle is enclosed by the rectus sheath.[2]

The posterior layer of the rectus sheath is deficient over the lower quarter of the rectus abdominal muscle, this is marked by the arcuate line, which defines the point where the posterior aponeurosis layer of the internal oblique and the aponeurosis of the transversus abdominis become part of the anterior rectus sheath, leaving only the relatively thin transversalis fascia to cover the rectus abdominal muscle posteriorly. This arcuate line is found one-third of the distance from the umbilicus to the pubic crest.[1]

Between the internal oblique and transversus abdominis muscles lies a plane that corresponds with a similar plane in the intercostal spaces. This plane contains the anterior rami of the lower six thoracic nerves (T7 to T12) and first lumbar nerve (L1), supplying the skin, muscles, and parietal peritoneum.[3]

At the costal margins, the thoracic nerves T7 to T11 enter this neurovascular plane of the abdominal wall, travelling along this plane to pierce the posterior wall of the rectus sheath as anterior cutaneous branches supplying the overlying skin. The nerves T7 to T9 emerge to supply the skin superior to the umbilicus. The T10 nerve supplies the umbilicus, whereas T11, the cutaneous branch of the subcostal T12, the iliohypogastric nerve, and the ilioinguinal nerve supply the skin inferior to the umbilicus.

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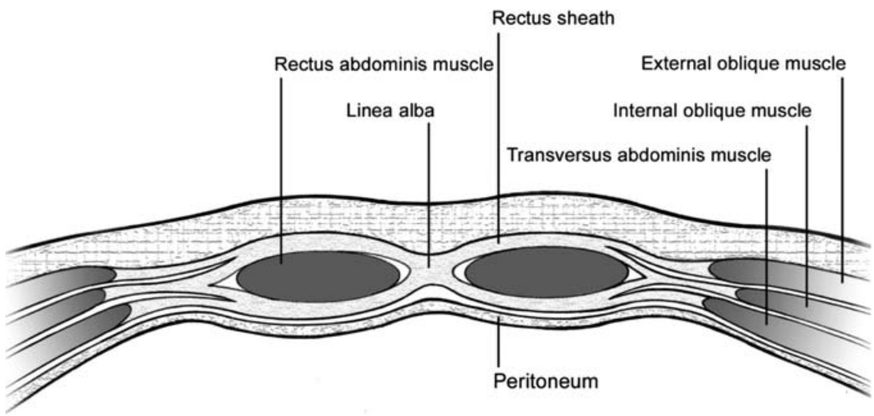

Fig 1 Muscle layers of the abdominal wall.

The iliohypogastric nerve originates from the L1 nerve root and supplies the sensory innervations to the skin over the inguinal region. The nerve runs in the plane between the internal oblique and transversus abdominis muscles and later pierces the internal oblique to lie between this muscle and the external oblique before giving off cutaneous branches.

The ilioinguinal nerve also originates from the L1 nerve root and is found inferior to the iliohypogastric nerve perforating the transversus abdominis muscle at the level of the iliac crest running medially in a deeper plane than the iliohypogastric nerve. The ilioinguinal nerve innervates the inguinal hernia sac and medial aspect of the thigh and anterior scrotum and labia.[4]

Clinical use

Regional analgesia of the abdominal wall can provide good analgesia for a variety of surgical operations especially when used as part of a multimodal technique (Table 1). Haemodynamic effects are minimal as spread of local anaesthetic is limited to the abdominal wall.

Although it has to be noted that these blocks only provide analgesia of the abdominal wall, and not the abdominal viscera, they have a role in decreasing analgesic requirements and can often be used even in major abdominal surgery when epidural anaesthesia is contraindicated. Using blocks of the anterior abdominal wall can be a useful addition in ambulatory surgery to improve the quality of analgesia and to reduce postoperative opioid requirements. The local anaesthetic agents used should reflect the aim of providing postoperative analgesia and so longer-acting local anaesthetic agents would provide the greatest benefit.

Table 1 Examples of operations and block suitability. *TAP blocks are unlikely to provide complete analgesia for upper abdominal incisions

Incision	Cutaneous nerve supply/dermatome	Suitable blocks
Midline laparotomy	T6–T12	Rectus sheath block (bilateral); TAP block (bilateral)*
Open appendix incision	T10–T11	TAP block
Open cholecystectomy incision	T6– T9	TAP block
Hysterectomy/LSCS via Pfannenstiel incision	L1	IL and IH (bilateral); TAP block (bilateral)
Open inguinal hernia repair	T12–L1	IL and IH; TAP block
Open umbilical hernia repair	T9–T11	Rectus sheath block (bilateral)

In practice, performing blocks of the anterior abdominal wall has traditionally relied on landmark techniques and detection of fascial 'pops' to identify the correct location and fascial plane for needle insertion and local anaesthetic deposition.

More recently, ultrasound techniques have been applied to facilitate the performance of these blocks. Ultrasound-guided techniques can be used with all anterior abdominal wall blocks, allowing direct observation of the correct needle placement and spread of local anaesthetic. This can also enable the identification of relevant anatomical structures and ensure complications are kept to a minimum. Obesity may make both the landmark and ultrasound approaches more challenging.

These blocks are most commonly performed as a 'single shot' technique. Catheter techniques are also possible when more prolonged analgesia is required but are not currently in widespread use.

Specific blocks

Rectus sheath block

The rectus sheath block was first described in 1899 and was initially used for the purpose of abdominal wall muscle relaxation during laparotomy before the adjunct of neuromuscular block.[5] Now, it is used for analgesia after umbilical or incisional hernia repairs and other midline surgical incisions.

The aim of this technique is to block the terminal branches of the 9th 10th, and 11th intercostal nerves which run in between the internal oblique and transversus abdominis muscles to penetrate the posterior wall of the rectus abdominis muscle and end in an anterior cutaneous branch supplying the skin of the umbilical area.

The most widely described approach is a blind technique, passing the needle through anterior rectus sheath and through the rectus abdominis muscle and injecting the local anaesthetic on the posterior wall of the rectus sheath.

With the patient lying supine, a point is identified 2–3 cm from midline, slightly cephalad to the umbilicus at the apex of bulge of the rectus abdominis muscle. A short-bevelled 5 cm needle, directed at right angles to the skin, is initially passed through the skin until the resistance of the anterior sheath can be felt. A definitive ‘pop’ should be felt as it passes through. The needle is advanced further until the firm resistance of the posterior wall is felt and injection of 15–20 ml local anaesthetic is made in 5 ml aliquots. The procedure is repeated on the opposite side of the midline.

There is a poor correlation between the depth of the posterior sheath and the age, weight, or height of patients meaning that it can be difficult to predict the depth of the rectus sheath.[5] The use of ultrasound allows non-invasive real-time imaging of the rectus sheath while the needle is placed under direct vision.

The ultrasound probe is placed in a transverse plane and positioned where there is optimum ultrasonographic visualization of the posterior rectus sheath. Either an ‘in plane’ or an ‘out of plane’ approach can be used. Local anaesthetic is injected between the rectus abdominis muscle and the posterior rectus sheath. In children, the use of lower doses of local anaesthetic has been described with ultrasound guidance compared with the landmark technique.[5]

With the posterior wall of the rectus sheath lying superficial to the peritoneal cavity, needle misplacement may lead to complications. Injection into the peritoneal cavity will lead to failure of the block and may risk bowel perforation or puncture of blood vessels, usually the inferior epigastric vessels.

In addition to incorrect placement of local anaesthetic, incomplete block may result from anatomical variance, as in up to 30% of the population, the anterior cutaneous branch of the nerves are formed before the rectus sheath and so do not penetrate the posterior wall of the rectus sheath.[2]

Ilioinguinal and iliohypogastric nerve blocks

Inguinal herniorrhaphy pain can be significant and difficult to treat without opioid analgesics, but blocking the iliohypogastric and ilioinguinal nerves can provide good analgesia for most operations in the inguinal region. These blocks may be very effective in reducing the need for opioids, and in paediatric patients, they have been found to be as effective as caudal blocks, albeit with a higher failure rate.[4]

The classical approach uses a landmark technique which blocks the nerves once they have separated into the different fascial layers. The injection is made at a point 2 cm medial and 2 cm cephalad to the anterior superior iliac spine using a short-bevelled needle advanced perpendicular to the skin. After an initial pop sensation as the needle penetrates the external oblique aponeurosis, around 5 ml of local anaesthetic is injected. The needle is then inserted deeper until a second pop is felt penetrating the internal oblique, to lie between it and the transversus abdominis muscle. A further 5 ml of local anaesthetic is injected to block the iliohypogastric nerve.[4] A fan-wise subcutaneous injection of 3–5 ml can be made to block any remaining sensory supply from the intercostals and subcostal nerve. This approach has a success rate of ~70% with failure often due to the local anaesthetic being placed more than one anatomical layer away from the nerves.[6]

Ultrasound has been used with an increased success rate to block the nerves proximal to the anterior superior iliac spine when both nerves can be identified in the fascial layer between the internal oblique and transversus abdominis muscles, before the iliohypogastric nerve has penetrated the internal oblique to lie below the external oblique aponeurosis. The ultrasound probe is placed obliquely on a line joining the anterior superior iliac spine and the umbilicus, immediately superior to the anterior superior iliac spine[7] (Fig. 2). It may not be possible to accurately identify each nerve exactly on ultrasound; therefore, the most important

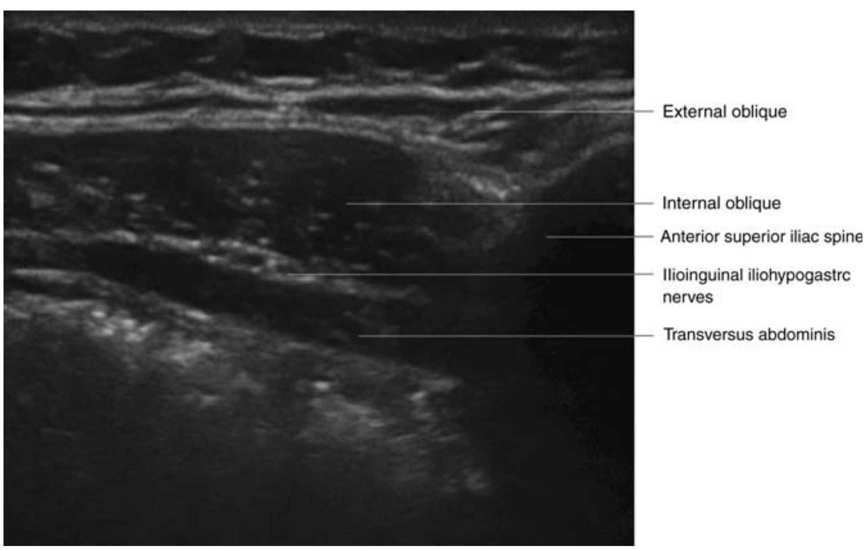

Fig 2 Ultrasound of ilioinguinal and iliohypogastric nerves.

aspect is to ensure that the needle is in the correct fascial layer. When the correct plane between the internal oblique and transversus abdominis muscles is identified, 10–15 ml of long-acting local anaesthetic is injected in 5 ml aliquots.

It is worth noting that if used as the sole technique for inguinal herniorrhaphy, the sac containing the peritoneum should be infiltrated with local anaesthetic by the surgeon as it is supplied by the abdominal visceral nerves.

The placement of the needle and local anaesthetic too deep may result in block failure and inadvertent femoral nerve block.[6] Injection into the peritoneal cavity will lead to failure of the block and may risk bowel perforation. Puncture of blood vessels, usually the inferior epigastric vessels, has been described. The use of ultrasound guidance may potentially reduce the incidence of these complications.

TAP block

The aim of the TAP block is to block the sensory nerves of the anterior abdominal wall before they pierce the musculature to innervate the abdomen.

The block can be performed either by using a landmark technique or with the aid of ultrasound. The aim is to place a large volume of local anaesthetic in the fascial plane between the internal oblique and transversus abdominis which contains the nerves from T7 to L1. The onset of the sensory block appears to be relatively slow, taking up to 60 min to reach maximal effect,[3] so ideally the block is placed at the start of surgery to give adequate time for the onset of sensory analgesia.

The block was originally described using a landmark technique. The TAP is accessed from the lumbar 'triangle of Petit', bounded anteriorly by the external oblique, posteriorly by the lattisimus dorsi, and inferiorly by the iliac crest (Fig. 3). This landmark is normally easily palpable,[8] although a cadaveric anatomical study has noted a large variability in the position of the 'triangle of Petit'[9] and can be difficult in the obese patient. The triangle is identified just anterior to the lattisimus dorsi muscle and a blunt tipped, short-bevelled needle is placed perpendicular to the skin immediately cephalad to the iliac crest. The needle is advanced through the external oblique and a first 'pop' sensation is felt when the needle enters the plane between the external oblique and internal oblique. Further advancement of the needle results in a second 'pop' after passing through the internal oblique fascia into the TAP (Fig. 4). At this point, after careful aspiration, 20 ml of long-acting local anaesthetic is injected in 5 ml aliquots.[3] For incisions at or crossing the midline, a bilateral TAP block is indicated.

Ultrasound can also be used to identify the muscle layers and ensure accurate placement of local anaesthetic. The ultrasound probe is placed transversely between the 12th rib and the iliac crest in the mid-axillary line. The TAP can easily be observed (Fig. 5) and using a 10 cm short-bevelled needle with an 'in plane' approach, local anaesthetic spread distending the plane between the transversus abdominis and internal oblique can be seen in real time.

The TAP block provides analgesia for the abdominal wall but not for the visceral contents and is ideally used as part of a multimodal approach to analgesia. Good postoperative analgesia and a decrease in morphine requirements for up to 48 h after operation have been demonstrated after a variety of surgeries including open colorectal surgery, retropubic prostatectomy, abdominal hysterectomy, and Caesarean section. Used bilaterally, it may be used as a simple alternative in patients for whom an epidural is not possible, although there is no comparative data as to the relative effectiveness of the two techniques.[10] Although a TAP block is unlikely to provide equivalent analgesia to an epidural technique, there may be less risk of systemic side-effects.

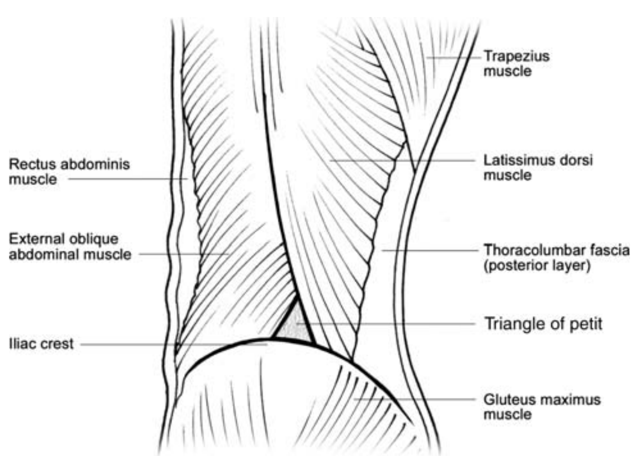

Fig 3 Muscle layers of the abdominal wall.

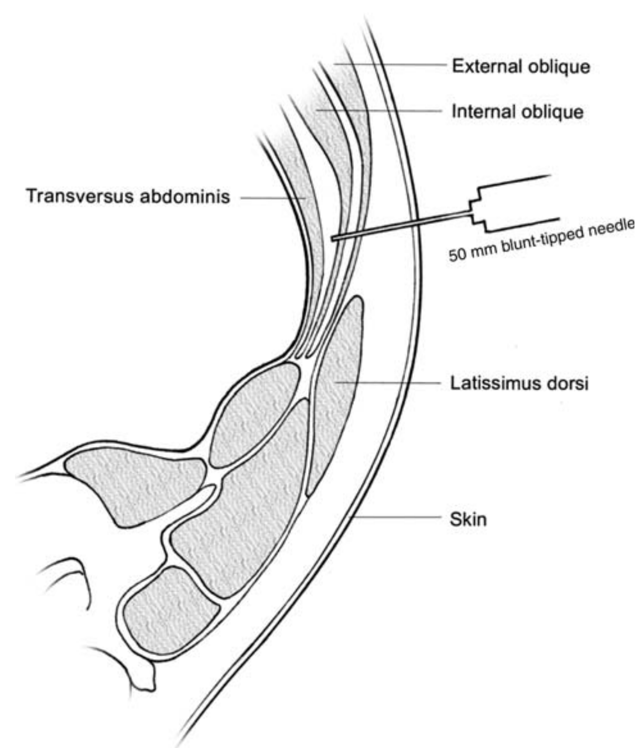

Fig 4 Placement of a TAP block.

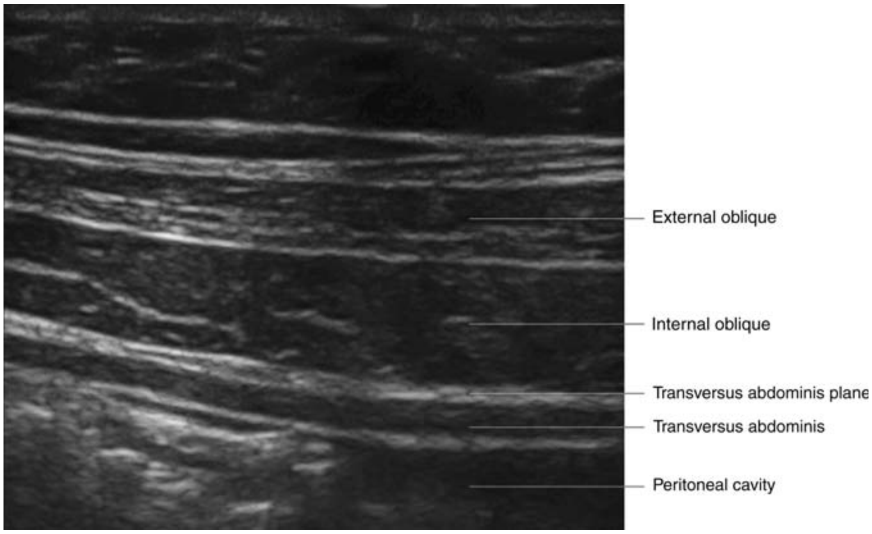

Fig 5 The TAP as observed on ultrasound.

Complications include block failure, intravascular injection, or injection into the peritoneal cavity, with associated risks of damage to bowel and other abdominal viscera. It is currently difficult to estimate the true incidence of complications due to the limited amount of published data.

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Conflict of interest

None declared.

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Please see multiple choice questions 13–16.