Transversus abdominis plane block

L Pillay

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## CONTENTS

Introduction ................................................................................................... 3

History ........................................................................................................... 4

Anatomy ........................................................................................................ 4

Performing the block ..................................................................................... 6

Anaesthetic agent ....................................................................................... 11

Clinical application / indications .................................................................. 12

Dangers ...................................................................................................... 12

Limitations ................................................................................................... 13

Areas of controversy ................................................................................... 14

Comparing with other analgesic techniques ............................................... 15

Literature Review ........................................................................................ 16

Conclusion .................................................................................................. 21

References .................................................................................................. 22
References

1. K. Webster, Update in Anaesthesia – The Transversus Abdominis Plane block: Abdominal plane regional anaesthesia.

Introduction

- Regional anaesthesia is a rapidly evolving sub-speciality area.
- The abdominal wall is a significant source of pain after abdominal surgery.
- Benefits of adequate post-op analgesia include:
  - Reduced post-op stress response.
  - Reduced post-op morbidity.
  - Improved surgical outcome.
  - Facilitates rehabilitation.
  - Accelerates recovery from surgery.
- Further benefits of effective regional analgesic techniques include:
  - Reduced pain intensity.
  - Decreased incidence of s/e from analgesics.
  - Improved patient outcome.
- Hence the growing interest in abdominal plane blocks.
- However the clinical utility of current approaches such as abdominal field blocks, ilio-inguinal & hypogastric nerve blocks are limited & the degree of block achieved can be unpredictable. A major reason for the relative lack of efficacy of these blocks is the lack of clearly defined anatomic landmarks leading to uncertainty regarding the exact needle positioning & the lack of a clear indication that the LA is deposited in the correct anatomical plane.
- Transversus abdominis plane block (TAPB), allows sensory blockade of lower abdominal wall skin & muscle via LA deposition above the tranversus abdominis muscle (TAM) – this blocks the sensory nerves of the anterior abdominal wall before they pierce the musculature to innervate the abdomen.
History

- Abdominal field blocks used in anaesthesia for surgery involving the anterior abdominal wall for several decades.
- Technique involving multiple injections of LA in the abdominal wall – used in the 1980’s.
- Improved with the blind landmark technique, via the Lumbar triangle of Petit.
- Clinical efficacy of Landmark technique & recent u/s guided techniques being investigated in several centres around the world.

Anatomy

- Muscle layers of the abdominal wall include:
  - Rectus medially
  - External oblique
  - Internal oblique
  - Transversus abdominis in the lateral abdominal wall

- Innervation of antero-lateral abdominal wall is from anterior rami of spinal nerves T7-L1.

- Limitations of the study:
  - Blocks performed by three different anaesthesiologists.
  - Difficulties in blinding these studies as there is an appreciable loss of sensation or paraesthesia associated with the TAPB
  - The study size was not adequate to assess block safety.

- Conclusion - TAPB holds considerable promise as part of multimodal analgesic regime after TAH, providing superior analgesia when compared to placebo up to 48 postop hours.

- Blocking nociceptive transmission from the surgical incision – met with relatively little success:
  - Qualitative systemic review by Moiniche et al found little evidence to support the use of instillation of LA into wound incision.
  - In contrast the combination of intraperitoneal & incisional bupivicaine did provide some analgesia.

Questions to be answered

- What is the adequate dose?
- What are plasma levels of the LA?
- Is the plane that crucial?
- What is the exact duration of the block?
- Can we use catheters in children?

Conclusion

- TAPB holds considerable promise as part of a multimodal analgesic regimen.
- Performed with ease.
- U/s guidance = method of choice where available.
- Excellent safety profile to date.
- Outstanding clinical utility in terms of reliable & effective analgesia in all studies thus far.
- Hence increasing popularity & use of the TAPB.
- Look forward to further data on the effects of the block & a wider range of possible techniques especially for targeting the upper abdominal wall & studies to answer the above posed questions.
• Morphine via PCA = mainstay, however can result in significant adverse effects (sedation, nausea & vomiting).

• Randomized, controlled, double-blind clinical trial by Carney J et al, published in Anaesthesia Analgesia May 2008:
  o 50 females undergoing elective TAH were randomized to undergo bilateral TAPB with ropivacaine 1.5mg/kg to a maximum of 150mg before surgical incision (n=24) versus placebo (n=26) in addition to standard post-op analgesia comprising patient-controlled IV morphine, diclofenac & acetaminophen.
  o In all patients the triangle of Petit was located easily on palpation.
  o Each patient was assessed postoperatively by a blinded investigator in the PACU & at 2, 4, 6, 12, 24, 36 & 48 hours.
  o results – TAPB:
    ➢ Reduced VAS pain score at rest & on movement.
    ➢ Reduced mean total morphine requirements in the first 48 postoperative hours – 55mg vs 27mg, p<0.001 (primary outcome measure).
    ➢ Longer time to first PCA morphine request.
    ➢ Reduced incidence of sedation (37% vs 63%).
    ➢ No significant difference in the incidence or severity of nausea – reason proposed is that the amount of morphine consumed in the TAPB group was sufficient to induce PONV
    ➢ No complications attributed to the block.

• These nerves run laterally between the TAM & the IOM layers of the abdominal wall.

• The TAPB aims to block these nerves with LA before they pierce the anterior abdominal wall.

• Branches from anterior rami:
  o Intercostal nerves (T7-T11), exit IC-spaces & run in neurovascular plane between the internal oblique muscle (IOM) & TAM
  o Subcostal nerve (T12), also travel in the same plane
  o Ilio-hypogastric & ilio-inguinal nerves (L1) also travel in the same plane.

• These give rise to lateral cutaneous branches in the mid-axillary line & an anterior cutaneous branch through the rectus muscle. These supply the skin from the midline to approximately the anterior axillary line.
• Motor innervation:
  o T7-T12 > pyramidalis & rectus muscle (RM)
  o Subcostal, ilio-hypogastric & ilio-inguinal > IOM & TAM.

• Sensory innervation:
  o T7-T11 > skin, costal parts of diaphragm, related parietal pleura & peritoneum
  o T7  > epigastrium
  o T10  > umbilicus
  o L1  > groin.

Performing the block

• Principle is to deposit LA into the tissue plane between the IOM & the TAM to achieve myocutaneous sensory blockade.
• Up to 30 minutes to be effective, therefore preferably performed after induction, before surgery.

• 4 methods:
  1. Landmark/blind technique:
     ➢ Based on surface anatomy landmarks.
     ➢ Landmark for palpation = triangle of Petit:
       o Lies above the pelvic brim in the mid-axillary line.
       o Usually an easily identifiable, fixed & palpable landmark.
       o Access point to the above mentioned neuro-fascial plane.
       o Inferior border of the triangle = iliac crest.

    ➢ Continuous infusion of 0.2% ropivacaine at 4mls/h was used for 72 hours.
    ➢ Reported benefits included:
      ➢ Low pain scores.
      ➢ Minimal use of supplemental opioid.
      ➢ Absence of nausea & vomiting.

• Case report of a TAPB for analgesia after caesarean section in a patient with an intracranial lesion by French JLH et al in the International journal of Obstetric Anaesthesia, 2009:
  o 24 year old previously fit & well woman presented at 18 weeks of gestation with complex partial seizures with secondary generalization.
  o MRI demonstrated a SOL in the L-cerebral hemisphere, consistent with an astroglial tumour.
  o Repeat MRI at 31 weeks showed increased mass effect & tonsillar herniation.
  o Neuroaxial blockade was inadvisable as the goal was to maintain cardiovascular stability & control intracranial pressure.
  o At 37 weeks she underwent elective c/s under GA (remifentanil, propofol, sux & sevoflurane).
  o After delivery & before emergence – bilateral TAPBs were inserted under u/s guidance. Chosen in this case as an adjunct to reduce the need for post-op opioid analgesia which might have precipitated neurological deterioration & respiratory depression & consequent exacerbation of borderline raised ICP.
  o Post-op also received PC-IV morphine, paracetamol & diclofenac.
  o Minimal morphine requirements post-op = 8mg in 18 hours.
  o Patient reported her overall pain during the first 24 hours as mild on mobilization, with none at rest.
  o She remained stable & returned to the ward the next day.
  o Like the previous clinical trial findings this case suggests that the TAPB has the potential to improve quality of patient care especially when central neuroaxial blockade is contra-indicated.

Clinical use – Total abdominal hysterectomy

• Commonly performed major surgical procedure – results in substantial post-op pain & discomfort with an important component of the pain being from the abdominal wall incision.
• Usually require multimodal post-op pain treatment regime.
Clinical use – efficacy after caesarean section delivery

- One of the most commonly performed surgical procedures worldwide.

- Effective post-op analgesia of key importance to facilitate:
  - Early ambulation
  - Infant care (breastfeeding, maternal-infant bonding)
  - Prevent post-op morbidity

- Analgesic regime needs to meet goals of providing safe, effective analgesia with minimal s/e for mother & her child.

- Prospective, randomized, controlled, double-blind trial of 50 elective patients by McDonnell JG published in Anaesthesia, Analgesia in 2008:
  - Spinal anaesthesia for the caeser.
  - Pfannenstiel incision.
  - Randomized to receive TAPB (landmark method, 1.5mg/kg ropivicaine to a maximum of 150mg at the end of the surgery) versus placebo in addition to standard analgesia (paracetamol, diclofenac & intravenous morphine).
  - Blinded investigator assessed patients at specific time intervals between 2 to 48 hours post-op
  - Results – TAPB:
    - Reduced VAS-pain score at rest & on movement.
    - Reduced mean total morphine requirements in the first 48 hours - 18mg versus 66mg in the placebo group, p<0.001.
    - Longer time to the first request of morphine.
    - Reduced incidence of sedation (0% vs 36%).
    - No complications from the block.
  - Limitations:
    - Difficulties in adequately blinding.
    - Study not large enough to assess safety.
    - Significantly high dose of LA although still within recommended safe dose range.
    - Post-op assessment limited to the first 48 hours however data indicated that the severity of pain in the control group had diminished substantially by that time & most patients no longer required systemic opioid therapy.

- Second publication on the use of TAPB after c/s described the placement of TAPB catheters under u/s guidance in 3 case reports:
  - Anterior border = lateral edge of the EOM.
  - Posterior border = lateral edge of the latissimus dorsi muscle.
  - Floor from superficial to deep = subcutaneous tissue, fascial borders of EOM, IOM & TAM respectively.

  - Puncture site is just above the iliac crest & just posterior to the mid-axillary line within the triangle of Petit.
  - 24G, blunt tipped, 50mm needle is inserted perpendicular to the skin.
  - Pop felt when the needle passes through the fascial extensions of the IOM i.e the tip is between the fascial layers of the EOM & the IOM.
  - A second pop indicates the needle is in the fascial plane above the TAM.
  - Triangle of Petit can be difficult to palpate especially in obese patients.
Rafi suggests a needle insertion point 2.5cm behind the highest point of the iliac crest when the triangle is not clearly palpable.

Getting the patient to lift his head & shoulders from the supine position will contract the abdominal muscles & assist palpation of the triangle.

2. Ultrasound technique:
   - Allows direct vision.
   - Relatively easy.
   - Broadband linear array probe used.
   - Imaging depth = 4-6cm.
   - Placed transverse to the abdomen in the mid-axillary line between the costal margin & the iliac crest.
   - The 3 muscle layers are clearly seen in the image.
   - A 100mm short bevel needle is used.
   - Inserted in a sagittal plane – 3-4cm medial to the u/s probe.
   - This point of insertion is closer to the u/s probe in children & further from the probe for obese adults.
   - For optimal imaging the needle should be parallel to the long axis of the u/s probe.
   - The probe is moved slightly anterior to image the skin puncture & superficial course then gradually posteriorly to the mid-axillary line

- The above findings define the anatomic characteristics of the TAPB & underline the clinical potential of this novel block.

Clinical use – retropubic prostatectomy

- Small trial of TAPB on 12 open retropubic prostatectomy patients in 2006.
- Used 20mls 0.375% bupivicaine to each side pre-operatively.
- Minimum morphine consumption was demonstrated.
- No adverse effects reported from the block.

Clinical use – large bowel resection

- 32 adults undergoing large bowel resection via a midline abdominal incision.
- Standard post-op analgesia regime (PCA, regular NSAIDs & paracetamol) for all patients.
- 16 patients randomized to placebo & 16 TAPB with the landmark technique (20mls 0.375% levo-bupivicaine).

- Results – TAPB group:
  - Decreased VAS pain scores at emergence & at all times measured postoperatively up to 24 hours at rest & on movement.
  - Morphine requirements in the first 24 postoperative hours were also reduced – 21.9mg vs 80mg (more than 70% reduction), p<0.05.
  - Longer time to first request for morphine.
  - Sedation scores reduced at 4 & 6 hours postoperatively.
  - PONV – reduced by more than half (69% vs 31%).

- High reported patient satisfaction level in the TAPB group.
- No complications from the block.
- Limitations of the study – difficulties to adequately blinding given that the block produces loss of sensation however the patients abdomens were not examined & the TAPB sites were covered by dressings in all the patients.
- Conclusion – TAPB provides highly effective post-op analgesia in the first 24 postoperative hours after major abdominal surgery.
• Also:
  - Enhances functional exercise capacity.
  - Enhances health-related quality of life.
  - Reduces hospital stay.

• However contra-indicated in certain situations where TAPB would then be useful:
  - Clotting
  - Sepsis
  - Patient refusal
  - Raised ICP
  - Tight stenotic valvular lesions
  - Unstable haemodynamic.

**Literature Review**

**Extent of the sensory block**

• 2004, McDonnell JG et al – cadaveric & live volunteers study:
  - Landmark technique - TAPB using methylene blue on cadavers & radio-opaque dye with 0.5% lignocaine on healthy volunteers.
  - Cadaver dissection revealed dye deposition in the transversus abdominis plane.
  - Live volunteers – CT imaging identified dye in the transversus abdominus neurovascular plane & pin-prick testing indicated sensory block from T8-L1 dermatome.

  - Used methylene blue via the triangle of Petit using the landmark technique on the cadavers.
  - Dissection revealed reliable deposition of the injectate into the transversus abdominis plane.
  - The 3 male volunteers were given a TAPB with radio-opaque dye & lignocaine to a final concentration of 0.5% & final volume of 20mls.
  - 20 minutes after the block CT imaging showed spread throughout the transversus abdominis plane & sensory block assessment revealed a block from T7-L1 which receded over 4-6 hours.

3. Subcostal TAPB:
  - For analgesia superior to the umbilicus as far superiorly as a cholecystectomy incision.
  - Rectus muscle near the costal margin is identified in the transverse view.
  - The u/s probe is then moved laterally to locate the transversus plane after passing the lateral edge of the rectus muscle.
  - The needle is inserted several cms from the probe to come into view in plane & near perpendicular.
  - The insertion may be from the medial or lateral side of the probe enabling the block to be performed bilaterally without changing operator position.
4. Oblique subcostal TAP block:
- Also capable of reliably providing analgesia above the umbilicus.
- Very suitable for catheter infusion.
- Tailored to the incision, starting midway to high in the abdominal wall.
- The nerves follow the direction of the costal cartilage therefore the height of the block is higher than the entry point.
- Ultrasound probe is held below & parallel to the costal margin, oblique to the sagittal plane.
- 100-150mm needle is inserted close to the xiphoid process underneath & through the rectus muscle as the muscular part of the TAM usually lies posterior to the rectus muscle in the superior part of the abdomen & in a plane to the u/s probe.
- The starting point is near the costal margin & either at the posterior rectus sheath or between the rectus & the TAM (depending on the position of the TAM behind the rectus).
- LA is deposited between the TAM & the rectus muscle.
- The needle is intermittently advanced with subsequent small injections to open the transversus plane progressively (hydro-dissection).
- The needle advances parallel to the costal margin towards the iliac crest.
- Advantage – reliable spread of sensory block above the umbilicus.

- A subset of 12 blocks (in the first mentioned audit) assessed after several hours (after spinal anaesthesia had regressed after caesarean section) the mean block height was 0.49 suggesting there was no extra spread over time.

**Comparing with other analgesic techniques**

**Single shot neuraxial analgesic technique using long-acting opioids or PC-epidural opioid**
- Effective analgesia.
- However s/e:
  - Nausea & vomiting
  - Pruritus
  - Above reduces overall patient satisfaction
  - Delayed respiratory depression due to rostral spread of hydrophilic opioids eg. morphine
- Also not always possible to provide neuraxial opioid analgesia due to logistic issues &/ the presence of medical contraindications.

**IV PCA-morphine**
- Facilitates a greater degree of patient control thereby resulting in high patient satisfaction levels.
- However analgesia produced is often incomplete.
- Opioid-mediated s/e remains common.

**Rectus sheath block**
- Misses the lateral & anterior IC-nerves.

**Epidural**
- Gold standard for abdominal surgery post-op analgesia to date.
- Ample evidence that it provides better post-op analgesia compared with parental opioids.
• If anatomy is abnormal eg. hepatomegaly, then there is a risk of damage from the needle puncture. However u/s techniques are likely to improve safety in this respect.

• Limitations of u/s guided TAPB:
  o Editorial in the BJA by Cowlishaw PJ, Jan-2009:
    ➢ No extension of the block above T10.
    ➢ Inguinal sparing in 20% of the cases, in keeping with anatomic dissections which show that the L1 branch or the ilio-hypogastric nerve often pierces the TAM in front of the anterior axillary line.
    ➢ In 10% of their cases found no extension of the block beyond the lateral border of the rectus muscle (lateral sparing).

Areas of controversy

• Debate in the literature regarding the extent of the sensory block achieved.
  o General agreement – reliable block spread between T10-L1 dermatomes using the landmark technique.
  o Initial publications found block height from T7-L1 however other investigators found that the block does not reliably rise above the umbilicus.
  o May be some gradual catch-up with infusions with the landmark technique.
  o In an audit of 21 landmark technique TAPB mean block height expressed as a proportion of the distance from the pubis to xiphoid process was 0.52 with the height of the umbilicus at 0.51.
  o In another audit of block to ice in 20 oblique subcostal TAPB the mean block height was 0.86.

• Time for spread of the block:
  o McDonnell & Laffey state that examining the extent of the block prior to full spread could be misleading:
    ➢ Demonstrated in volunteer studies that the TAPB continues to extend gradually as the LA spreads along the neural plane with a maximum extent of the block evident only after several hours & measurement is most accurate when full block height is achieved.
  o however some investigators have found the block height does not continue to extend over hours:

### Anaesthetic agent

• The volume of injectate is critical to the success of the block – adequate volume is more important than strong concentrations.
• Adhere to maximum safe dose of the chosen agent.
• In an average sized adult 30ml of LA – for unilateral block & 25-30mls each side for a bilateral block.
• Lignocaine, bupivicaine (duration of effect up to 24 hours with levo-bupivicaine) & ropivicaine (duration of effect up to 36hours) – used with success.

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Clinical application / indications

- Supplemental anaesthesia & post-op analgesia for any surgery involving the lower abdominal wall:
  - bowel surgery
  - c/s
  - appendicectomy
  - hernia repair
  - umbilical surgery
  - gynaecological surgery

- If combined with subcostal or oblique subcostal technique then covers surgery for upper abdominal wall as well.
- Where an epidural is contraindicated or refused.
- Unilateral eg. for appendicectomy or bilateral where the incision crosses the midline.
- Single injection or catheter inserted for several days of analgesic benefit.
- Rescue analgesia on awake post-op patients who did not receive blocks prior to abdominal surgery.
- Prolonged duration of analgesic effect – TAP is relatively poorly vascularized therefore drug clearance may be slowed.

Dangers

- The following are applicable to all regional blockades however the TAPB is relatively low risk.
  - needle trauma
  - intraneural injection
  - neural ischaemia
  - inadvertent intravascular injection
  - local anaesthetic toxicity
  - infection
  - poor/failed block

- Theoretical risk of significant flank haematoma as a result of injury to small vessels running with the nerves.

- Until late last year only 1 published report of complication from the landmark technique – TAPB was performed on a woman for abdominal hysterectomy (50kg in weight & 160cm tall), at laparotomy approximately 50mls of fresh blood was found in the abdomen due to needle perforation of the liver, the liver was found to be enlarged & reached the right iliac crest.

- A letter to the Editor by Jankovic Z et al in Anaesthesia, Analgesia November 2008 highlighted the following complications:
  - During 1 open nephrectomy, wherein continuous TAPB was used the tip of the TAP catheter was found in the abdomen (without any visceral organ damage).
  - A study using u/s to check the actual location of LA placement during TAP block revealed that intraperitoneal injection had occurred in 2% of patients.
    - Bowel haematoma.
    - Transient femoral nerve palsy.
    - Catheter breakage.

- The same authors above suggested the following to minimize these complications:
  - Use of a fine-gauge, blunt-tipped, short bevel needle.
  - Directing the needle obliquely instead perpendicularly to increase the resistance of each apneurosis.
  - Use smaller volumes of LA to decrease the incidence of femoral nerve block.

- No published cases of complications from the u/s technique.

Limitations

- It has been reported that the lumbar triangle of Petit offers an easily identifiable, fixed & palpable landmark however many clinicians have found the landmark anything but easy to identify & is especially more challenging in the obese hence the risk of peritoneal perforation. However some clinicians argue that peritoneal perforation with a small gauge sterile needle is not likely to be significant.

- Landmark technique relies on the pop sensation – some clinicians believe this is an imprecise sign.