Anaesthesia for transurethral resection of the prostate

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Key points

Spinal anaesthesia is considered to be the technique of choice for TURP.

TURP syndrome comprises the effects produced by rapid changes in osmolality and circulating volume, together with the effects of glycine, caused by the absorption of glycine 1.5%.

In TURP syndrome, hypoosmolality is more important than hyponatraemia in causing central nervous system disturbances.

TURP syndrome treatment can be divided into management of volume changes and management of solute changes (hyponatraemia, hypoosmolality, and direct toxicity of irrigation fluid used).

Newer techniques of transurethral prostatic resection promise a reduced risk of TURP syndrome.

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Approximately 40 000 transurethral resections of the prostate (TURP) are performed annually in the UK. TURP remains the surgical gold standard for the treatment of benign prostatic hyperplasia (BPH), which causes urinary obstruction and increases the risk of urinary tract infection. Perioperative morbidity from this procedure ranges between 18% and 26% and the mortality rate may be as high as 1%.[1,2] Between 1% and 8% of TURP procedures are complicated by the TURP syndrome.[3]

TURP is usually performed in patients in whom the prostate weighs <60 g.[4] Open prostatectomy may carry fewer complications, if the prostate is very large (>100 g). Prostatic size may be assessed by bimanual examination, transrectal ultrasound scanning, and endoscopic inspection.

Relevant anatomy

The prostate gland (normal weight: 20 g) encircles the urethra as it emerges from the base of the bladder. It comprises glandular (secretory acini) and non-glandular (smooth muscle and fibrous tissue) components enclosed by a fibrous capsule. It has a rich blood supply and venous drainage is via the large, thin-walled sinuses adjacent to the capsule.

It is described as having four histological zones (McNeal zones): the central, peripheral, anterior (fibromuscular), and transitional (periurethral) zones. The transitional zone surrounds the proximal urethra in two pear-shaped lobes. It comprises 5% of normal prostatic volume and is the site of BPH and also ~10% of prostatic carcinomata. Twenty per cent of men aged 40 yr have hyperplasia of the transition zone, increasing to 50% at 50 yr and 70% at 60 yr. The hyperplastic tissue eventually encroaches on the proximal urethra, causing obstruction. The normal prostatic tissue becomes compressed against the capsule, and is often referred to as the 'surgical capsule'.

The nerve supply to the prostate arises from the prostatic plexus, which originates from the inferior hypogastric plexus, and carries both sympathetic fibres from T11 to L2 and parasympathetic fibres from S2 to S4. Pain fibres from the prostate, prostatic urethra, and bladder mucosa originate primarily from sacral nerves S2 to S4. Pain signals from bladder distension travel with sympathetic fibres and have their origin in T11–L2. The sensation of stretch in the bladder (proprioception) is carried by the parasympathetic fibres of S2–S4.

Surgical technique

The operation is performed using a resectoscope, through which a diathermy loop is passed. The aim of the procedure is to resect the hyperplastic tissue while sparing the surgical capsule, although it does not form a well-defined plane with the surgical capsule. The prostatic tissue is resected in small strips under direct vision using the diathermy loop, which can both cut and coagulate. The bladder is continuously irrigated with fluid to allow direct vision and to wash away blood and debris. At the end of the procedure, a three-lumen catheter is inserted and irrigation is continued for up to 24 h after operation. The procedure usually takes 30–90 min, depending on the size of the prostate and the level of experience of the operator. It is performed in the lithotomy position, sometimes with head-down tilt.

Irrigation fluid

The ideal irrigation fluid is transparent (for good visibility), electrically non-conductive (to prevent dispersion of the diathermy current), isotonic, non-toxic, and non-haemolytic when absorbed, easy to sterilize, and inexpensive. However, no solution fulfils all of these criteria.

The most common irrigation fluid used in the UK is glycine 1.5%,[5] which has an osmolality of 220 mosmol kg^{-1}, making it hypotonic

with respect to plasma ($280-300$ mosmol kg^{-1}). Other solutions available include mannitol 5% and sorbitol 3.5%.[3]

Patient group

Patients are usually elderly, and may have coexisting diseases involving several systems. In one large series, the average age of the patient was 69 yr and only 23% did not have a significant medical condition before surgery. In this study, the most common associated medical conditions were: pulmonary (14.5%), gastrointestinal (13.2%), myocardial infarction (12.5%), cardiac arrhythmias (12.4%), renal insufficiency (9.8%), and diabetes (9.8%).[2]

Preoperative assessment should include a full medical history and examination and also a full blood count, electrolyte screen, electrocardiograph, and chest radiograph, if indicated. Special attention should be paid to the cardiovascular status, especially heart failure, where fluid absorption increases the risk. Chronic prostatic hypertrophy may cause obstructive renal insufficiency and urinalysis is mandatory to exclude a urinary tract infection, as if this is left untreated, it increases the risk of postoperative septicaemia. Furthermore, this group of often elderly patients may have osteoarthritis or prosthetic joints which render positioning difficult and increase the risk of musculoskeletal injury and pressure sores.

Choice of anaesthetic technique

Spinal anaesthesia

Spinal anaesthesia is regarded as the technique of choice for TURP, although there is little evidence to demonstrate significant difference in outcomes between general and spinal anaesthesia.[6]

Spinal anaesthesia may offer several advantages over general anaesthesia.[5] It is particularly useful for patients with significant respiratory disease. It confers good postoperative analgesia and may reduce the stress response to surgery. More importantly, spinal anaesthesia allows the anaesthetist to monitor the patient's level of consciousness, which makes it easier to detect the early signs of TURP syndrome. Early recognition of capsular tears and bladder perforation is also possible as the patient complains of periumbilical or shoulder pain provided the spinal level is limited to T10.[5] Spinal anaesthesia has traditionally been avoided in patients with ischaemic heart disease; however, the incidence of myocardial ischaemia is the same for spinal and general anaesthesia.[7] A spinal block to T10 is required to eliminate the discomfort caused by bladder distension: $2.5-3.0$ ml of 0.5% plain or hyperbaric bupivacaine may be used. Pencil-point spinal needles are associated with a very low rate of dural puncture headache.

Severe hypotension is uncommon with the above spinal technique. The lithotomy position may compensate for sympathetic block by improving venous return (however, hypotension may be unmasked when the legs are lowered at the end of the operation). Treatment of hypotension with vasoconstrictors rather than rapid fluid administration is encouraged to reduce the risk of fluid overload. Careful monitoring of arterial pressure throughout the

operation and afterwards is recommended. If required, sedation may be provided with $1-2$ mg of midazolam i.v., although this may cause confusion, disinhibition, and restlessness. Propofol infusion may be more successful.

General anaesthesia

In circumstances where general anaesthesia is preferred (patient has a contraindication to spinal anaesthesia, unable to lie supine for any length of time, or has a persistent cough which make surgery difficult), the choice of airway will depend on patient factors. The lithotomy position in combination with a head-down tilt reduces tidal volume and functional residual capacity, and increases the likelihood of gastric regurgitation. Tracheal intubation and positive pressure ventilation may counteract these problems. However, the use of a laryngeal mask airway with spontaneous ventilation in selected patients is an acceptable alternative. Postoperative analgesia may be provided by a single-shot caudal epidural injection [e.g. with plain bupivacaine 0.375% ($20-25$ ml)]. Under light planes of general anaesthesia, penile erection may interfere with surgery. It can usually be managed by deepening anaesthesia. Spinal anaesthesia does not always prevent this complication.

Local anaesthesia

Limited TURP in high-risk patients has been performed using local infiltration of the perineum and the prostatic fossa. However, the quality of operative analgesia is inferior to a spinal anaesthetic and the prostate gland size should be <40 g. This technique cannot be recommended and alternative treatments should be explored.

A single slow i.v. bolus of gentamicin ($2-4$ mg kg^{-1}) or other comparable alternative antibiotic should be given to prevent bacteraemia during instrumentation of the urinary tract.[5]

Potential intraoperative problems

Excessive intraoperative absorption of irrigation fluid may lead to the TURP syndrome. Some blood loss is inevitable (Table 1). Both of these problems are discussed in more detail below.

Myocardial ischaemia may occur in up to 25% of patients during TURP, with myocardial infarction occurring in $1-3$%.[7] Elderly patients are prone to hypothermia, particularly if the irrigating solution is at room temperature. Warmed irrigation fluids have not been shown to cause any increase in blood loss by local vasodilation[8] and should be used in conjunction with active patient warming devices (e.g. the Bair Hugger).

Occasionally, the surgeon may perforate the prostatic capsule (up to 10% of cases),[3] urethra, or bladder with the resectoscope (up to 1.1% of cases).[8] Most small perforations do not require further intervention. Prostatic capsular perforation may be associated with excessive bleeding, and require placement of a

Table 1 Potential problems during TURP

Intraoperative
  TURP syndrome
  Haemorrhage
  Myocardial ischaemia
  Hypothermia
  Prostatic capsular perforation
  Bladder or urethral perforation
  Penile erection
Postoperative
  TURP syndrome
  Bladder spasm
  Ongoing bleeding
  Clot retention
  Deep venous thrombosis
  Myocardial ischaemia/infarction
  Postoperative cognitive impairment

retroperitoneal drain. Intraperitoneal perforation may be indicated by shoulder-tip pain in patients with subarachnoid anaesthesia.

Potential postoperative problems

Postoperative pain is not usually severe after either spinal or general anaesthesia, although discomfort from bladder spasm or from the urinary catheter may occur (Table 1). It is unusual to require opioids after operation. Catheter pain may be treated with lidocaine gel.

Bladder spasm may be treated with muscarinic receptor antagonists (e.g. hyoscine butylbromide, tolteridine, or oxybutynin), although there is an increased risk of precipitating delirium in elderly patients. Alternatives are benzodiazepines or a subhypnotic dose of ketamine (250 μg kg^{-1}). Clot retention may occur after operation, particularly if irrigation is inadequate, and may lead to bladder overdistension, which is painful and may precipitate severe bradycardia due to vagal stimulation. Mechanical measures such as flushing the bladder or milking the catheter may be successful, but occasionally the patient may need to be taken back to theatre for evacuation of a bladder haematoma.

This patient group is at particular risk from deep venous thrombosis. For low-risk patients with good mobility, compression stockings are usually adequate prophylaxis. Low-molecular-weight heparin should be considered in patients at higher risk (poor mobility, malignancy, intercurrent illness, and obesity). Postoperative cognitive impairment is also common in this patient group.[3]

Haemorrhage

Blood loss during TURP is inevitable and is typically in the region of 500 ml. It is difficult to quantify due to the large volume of irrigating solution used. Patients lose between 2.4 and 4.6 ml of blood per minute of resection whichever anaesthetic technique is used.[8] In theory, blood loss can be estimated by assaying the haemoglobin concentration of the discarded irrigation fluid, by measuring the electrical conductivity of the discarded irrigation fluid, or in the laboratory by radioactive albumin or red-cell labelling techniques. Visual assessment of the colour of the discarded irrigation fluid is unreliable.

Factors associated with excessive bleeding include a large gland, extensive resection ($>$40–60 g of prostate chippings), coexisting infection, prolonged surgery ($>$1 h), and the presence of a preoperative urinary catheter. The histology of the gland is not associated with differences in bleeding.[9] In practice, frequent measurement of the haemoglobin is the most useful investigation.

Urokinase released from raw prostate tissue may provoke systemic fibrinolysis which may worsen postoperative haemorrhage. Where blood loss is extensive, a bolus of tranexamic acid, e.g. 15–25 mg kg^{-1}, may reduce the volume of haemorrhage.

For patients with a normal preoperative haemoglobin, who undergo a small resection ($<$30 g), it is very unusual to require blood transfusion after operation.[9]

TURP syndrome

The TURP syndrome is essentially a clinical diagnosis based upon a constellation of symptoms and signs associated with excessive absorption of irrigating fluid into the circulation. It comprises acute changes in intravascular volume, plasma solute concentrations, and osmolality, and direct effects of the irrigation fluid used (glycine and its metabolites in the UK, as glycine 1.5% is the most common irrigation fluid used). The effects are proportional to the volume of irrigating solution absorbed. The presentation is not always uniform, and milder cases may be unrecognized. Other types of endoscopic surgery that require the use of irrigation solution, e.g. hysteroscopy, may also give increase to the TURP syndrome.[3]

Mild-to-moderate TURP syndrome may occur in 1–8% of patients.[3] The overall mortality is 0.2–0.8%. It may present as early as 15 min after resection starts or as late as 24 h after operation.[10] Severe TURP syndrome is now rare; however, it carries a mortality of up to 25%.[3]

When glycine 1.5% is used as the irrigation fluid, early features of this syndrome include restlessness, headache, and tachypnoea, or a burning sensation in the face and hands. Visual disturbance including transient blindness may be reported. Features of increasing severity include respiratory distress, hypoxia, pulmonary oedema, nausea, vomiting, confusion, convulsions, and coma. General anaesthesia may mask the early symptoms, and the only sign may be cardiovascular instability.

Irrigation fluid is absorbed at a rate of between 10 and 30 ml min^{-1} of operating time.[10] Five to 20% of patients will absorb $>$1 litre.[3] In some centres, ethanol 1% is added to the irrigation solution and the patient's breath is tested for ethanol every few minutes: a positive test indicates a significant quantity of fluid has been absorbed. This method is well evaluated and is practically easier than other methods involving either gravimetric weighing (patient placed on a bed scale and any increase in body weight equates to fluid absorption) or volumetric fluid balance (calculating

the difference between the amount of irrigating fluid used and volume recovered).[3]

A higher rate of absorption is produced by several factors.

1. The pressure of the irrigation fluid. The height of the bag should be kept as low as possible to achieve adequate flow of fluid. Seventy centimetres are usually satisfactory. However, the surgeon will frequently stop and drain the bladder to remove chippings; during this time, the hydrostatic pressure within the bladder is low.
2. Low venous pressure, e.g. if the patient is hypovolaemic or hypotensive.
3. Prolonged surgery, especially >1 h, although this is now uncommon.
4. Large blood loss, implying a large number of open veins.
5. Capsular perforation, or bladder perforation, allowing a large volume of irrigation fluid into the peritoneal cavity, where it is rapidly absorbed.

Volume changes

Acute volume changes predominantly affect the cardiovascular system. The rapid absorption of a large volume of irrigation fluid can cause hypertension with reflex bradycardia, and can precipitate acute cardiac failure and pulmonary oedema. The magnitude of the hypertension is not related to the volume of fluid absorbed.

Rapid equilibration of hypotonic fluid with the extracellular fluid compartment may precipitate sudden hypotension in association with hypovolaemia. Hypotension and hypovolaemia may be compounded by the sympathetic block of spinal anaesthesia. This secondary phase at the end of the operation is often the first sign suggestive of the TURP syndrome.

Solute changes

Acute changes in plasma sodium concentration and osmolality predominantly affect the central nervous system (CNS). Acute hyponatraemia is produced initially by the dilutional effect of a large volume of absorbed irrigation fluid, but later is caused by natriuresis, and may cause headache, altered level of consciousness, nausea and vomiting, seizures, coma, and death. However, hypoosmolality is more important than hyponatraemia in CNS disturbance. The Nernst equation predicts that a moderate decrease in extracellular sodium concentration only minimally alters membrane excitability.[10] Patients who are hyponatraemic but have a normal osmolality are likely to be asymptomatic. Rapid reduction in plasma osmolality overwhelms neuronal compensatory mechanisms. Free water is absorbed into the brain parenchyma, causing water intoxication, cerebral oedema, and raised intracranial pressure.[3]

Serum sodium concentration should be measured in conjunction with serum osmolality. If the osmolality is normal or nearly so, no intervention is recommended to correct serum sodium if the patient is asymptomatic.[10] Rapid correction of hyponatraemia may lead to central pontine myelinolysis (CPM). The presence of symptoms has been described as the most important factor determining morbidity and mortality from hyponatraemia.[10] An acute decrease to <120 mmol litre^{-1} is invariably symptomatic and should be treated with hypertonic saline.[11]

Dilutional hyponatraemia may prolong the action of nondepolarizing neuromuscular blocking agents, and may cause broadening of the QRS complex or T-wave inversion.

Glycine and its metabolites

Glycine is a major inhibitory neurotransmitter in the CNS and retina. Glycine toxicity may cause nausea, headache, malaise, and weakness, and also visual disturbances including transient blindness (sodium appears to play only a minor role in visual disturbances). Glycine may also directly depress the myocardium.

N-methyl D-aspartate (NMDA) receptor activity is potentiated by glycine, which paradoxically may precipitate encephalopathy and seizures. Magnesium (whose plasma level may also be reduced through dilution) exerts a negative control on the NMDA receptor and also having a membrane-stabilizing effect, and magnesium therapy should be considered as part of the therapy for seizures in TURP syndrome.[10]

The liver and kidneys metabolize glycine by oxidative deamination to glyoxylic acid and ammonia. The redistribution half-life of glycine is 6 min. The terminal half-life of glycine is dose-dependent and varies from 40 min to several hours.[3] The role of hyperammonaemia during TURP syndrome remains unclear,[10] although ammonia is considered to be a cerebral depressant.

Treatment

If TURP syndrome is suspected, surgery must be abandoned as soon as possible and i.v. fluids stopped (Fig. 1). Treatment should involve supporting respiration (if necessary, with intubation and ventilation) and the circulation. Bradycardia and hypotension should be treated with atropine, adrenergic drugs, and i.v. calcium. I.V. anticonvulsants (e.g. diazepam or lorazepam) should be used to control seizures and i.v. magnesium therapy considered, if seizures prove difficult to control. Blood should be obtained and checked for sodium, osmolality, and haemoglobin.

Diuretic therapy (e.g. i.v. furosemide 40 mg) is only recommended to treat acute pulmonary oedema caused by the transient hypervolaemia. Furosemide worsens hyponatraemia, but is effective at removing free water. Mannitol (e.g. 100 ml of 20%) causes less sodium loss than loop diuretics.

Hypertonic saline (3%) is indicated to correct severe hyponatraemia, if serum sodium <120 mmol litre^{-1} or if severe symptoms develop, for example, transient blindness, persistent nausea and vomiting, severe headaches, and pronounced hypotension (systolic pressure decrease >50 mm Hg). The rate of correction should be slow (not >1 mmol litre^{-1} h^{-1} in the first 24 h)

Severe TURP syndrome

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Stop surgery as quickly as possible
Give 100% O_2
Airway: intubate if necessary
Breathing: IPPV if necessary
Circulation: give inotropes/vasopressors
Control seizures with diazepam or
lorazepam. Consider Mg^{2+}

⇩

Take blood for $[Na^+]$, Hb, osmolality
If hypervolaemia or pulmonary oedema,
give diuretic, e.g. furosemide 40 mg or
mannitol 20% 100 ml
Insert arterial ± CVP lines

⇩

If $[Na^+]$<120 mmol litre^{-1} or severe symptoms
give NaCl 3% according to body weight

Aim to correct $[Na^+]$ by 1 mmol litre^{-1} per
h^{-1} until symptoms improve
Admit to HDU or ICU
Continue to monitor $[Na^+]$, Hb, and
osmolality frequently

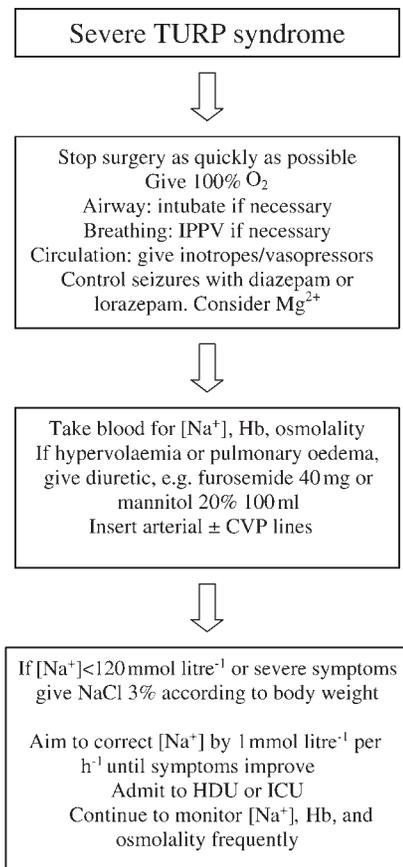**Fig 1** Management of severe TURP syndrome.

Table 2 Use of hypertonic saline

Calculate total body water as 0.6×body weight (kg), e.g. for a 70 kg man, TBW=42 litre

2×TBW is the number of millilitres of NaCl 3% which will raise serum [Na] by 1 mmol litre^{-1}, e.g. 2×42=84 ml of NaCl 3% over 1 h will raise serum sodium by 1 mmol litre^{-1}

(Table 2). Too rapid a correction may lead to hypervolaemia, cerebral oedema, and CPM. Correction to normal is not indicated: the aim should be clinical improvement. Hypertonic saline should be given into a large vein.

Invasive monitoring of arterial and central venous pressures is very helpful in managing patients with large fluid shifts. Transferring the patient to a high-dependency or intensive care environment after operation is advised (TURP syndrome may worsen later as irrigation continues after operation and fluid may continue to be absorbed).[11]

Visual disturbances caused by glycine typically resolve fully within 24 h and require no treatment. Patient reassurance is vital to allay anxiety.[10]

Newer techniques of prostatic resection

Newer techniques of prostatic resection use different types of energy (heat, laser, ultrasound, or microwave) to vaporize prostatic tissue and coagulate surrounding blood vessels. These techniques are reported to cause less haemorrhage than conventional TURP, but specimens for histology cannot be obtained. Since diathermy is not used, normal saline may be used as the irrigating solution, minimizing the risk of the TURP syndrome.[12]

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