Anesthesia for Short Procedures

36

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36.1 Introduction

Newborns undergoing surgery present several challenges for the anesthesiologist, whether minor or major procedures. Concerns are more for short and minor procedures because the anesthesia requirement and risk remain the same, but with greater need for exercising care so that the baby recovers well after the procedure.

A multispecialty approach works the best as anesthesiologist is involved in the neonatal care only at the time of surgery. Communication and cooperation between the entire health care team (surgeon, anesthesiologist, neonatologist, nursing, and technical staff) is essential preoperative requirement for the best outcome. The anticipation, prevention, and efficient and prompt management of complications may be lifesaving.

Any surgery undertaken in a newborn or a neonate is critical. Many of these are minor procedures, and short in duration, and though usually elective, many are often done on emergency basis. Many of these minor or short procedures, if undertaken in the neonatal period, are done on emergency basis and are frequently associated with other multisystem abnormalities including congenital heart disease and RDS, and carry the same anesthesia risk as for any other major procedure. On top of that, since these are short minor procedures, they usually last for less than 60 min, and more often 30–45 min. The goal of anesthetic management is that the neonate recovers soon after surgery without need for postoperative ventilatory support or NICU care [1].

Anesthetic concerns and requirements, OT preparation, are the same as in any newborn or neonate, undergoing major surgery. All precautions to prevent hypothermia must be taken.

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All care must be taken as described in the chapter on anesthetic considerations in the newborn, neonate, and premature.

Common short procedures that a newborn baby or a neonate may have to undergo, are follows:

1. **Lower Abdominal and Perineal Procedures -** Umbilical hernia, Inguinal hernia, Undescended testis, Hydrocele, Torsion testis, Circumcision, Cystoscopy, and PUV fulguration,
2. **Gastro Abdominal procedures -** Gastrostomy, Colostomy, Intraperitoneal drain placement,
3. **Tracheostomy,**
4. **Infective (drainage, debridement) -** Necrotizing Fasciitis (NF), septic arthritis,
5. **Birth injuries (BI), Neonatal care injuries (NCI),** and
6. **Ventriculoperitoneal (VP) shunt** placement.

36.2 Anesthetic Concerns for Short Procedures in Neonates

Anesthetic management and choice of anesthetic drugs largely depend upon the condition of the neonate, gestational age at birth, weight, birth weight, associated medical or other abnormality, and type of surgical emergency or procedure. Careful titration of drug dosage is important to reduce the risk of anesthesia, while achieving the desired effect. Factors to be kept in mind when planning anesthesia for such babies are as follows:

1. How well the baby has adapted to postnatal environment.
2. Immature organ systems, which are still growing and maturing. Immature hepatorenal system and effect of drug metabolism and excretion. Immature autonomic nervous system and poor hemodynamic adjustments and sympathetic responses. Immaturity of neuromuscular junction and sensitivity to muscle relaxants.
3. Presence of congenital abnormalities such as congenital cardiac defects, RDS, cleft lip or palate, and other anomalies. They may suffer from various medical conditions, which are undiagnosed and untreated and increase the surgical and anesthesia risk.
4. Brain and Blood Brain Barrier immaturity and sensitivity to anesthetic drugs (induction agents, narcotics, and sedatives).
5. Hematological and coagulation abnormalities, risk of hypothermia, hypoxemia, electrolyte changes, and dehydration and hypoglycemia with prolonged fasting.
6. Preoperative investigations may not be available and blood not arranged for transfusion.
7. On top of that, since these are short minor procedures, it is expected that both induction and recovery should be quick and rapid, with no residual effects, and monitoring takes a back step, and invasive monitoring is usually not considered.
8. There should be no need for postoperative ventilatory support, but need postoperative observation for a few hours at least, best for 12 h.

36.3 Anesthetic management – General Considerations

Patient and OT preparation: A detailed preoperative evaluation and risk stratification must be done, informed consent taken and documented, just as for any other surgery. Usually these procedures are short, not more than 60 min duration. OT preparation suitable for a neonate, prevention of hypothermia, and equipped with appropriate equipment. Anesthesiologist and other OR staff must be well-trained in caring for neonates.

Anesthesia induction and maintenance: GA is the usual technique of choice. Both inhalational and intravenous inductions are suitable depending on the availability of a peripheral IV line. Airway can be managed using SGD /LMA or ET tube. Wherever possible, SGD is preferred, avoiding need of muscle relaxant and endotracheal intubation. Most procedures, except abdominal, can be performed with baby retaining spontaneous respiration, assisted at intervals. Avoid or minimize the use of muscle relaxants and narcotics.

Analgesia: Any surgical intervention is painful. Multimodal analgesia is safer technique for both intra and postoperative pain, and babies should not be deprived of this, however short the procedure. Short-acting drugs, with predicted duration of action and effect, are preferred. Careful titration of drug dosages is advocated to get the desired effect, without adverse effects. Avoid unnecessary administration of drugs and undue polypharmacy.

Monitoring: Minimal basic monitoring includes heart rate, blood pressure (NIBP), respiratory rate, and saturation (SpO_2). Invasive monitoring is usually not mandated.

Preoperative fasting and Fluid therapy - Fluid loss and third space shifts are minimal. Careful calculation of fluid deficits, intraoperative losses, and replacement must be done, avoiding overloading and under transfusion. Blood loss is minimal and blood transfusion is not required, but always get blood grouping and keep cross-matched blood available. Main concern during short surgeries is inability to replace fasting deficits (which traditionally are calculated and given over 3-h period). This makes neonate at risk of hypovolemia even when there is hardly any intraoperative fluid or blood loss. Rapid fluid infusion puts the neonate at risk of fluid overload. To avoid this, keep NPO period to minimum (2 h for clear fluids). If longer preoperative NPO status is deemed necessary because of the type of surgery, start dextrose containing IV fluids to avoid dehydration and hypoglycemia.

Recovery from anesthesia: Anesthesia for short procedures in a newborn or neonate is a skillful task. Babies are at risk of delayed recovery from overdose of anesthetic drugs, inadequate recovery of neuromuscular block, opioids, hypothermia, fluid and electrolyte imbalance and hypoglycemia, etc. Increased proneness to pulmonary aspiration adds further to delayed recovery. Hence, these babies require monitored postoperative care.

36.4 Specific Short Procedures

Perioperative concerns, care, precautions, dos and don'ts, and anesthesia technique, specific to the procedure, will be discussed.

36.4.1 Lower Abdominal and Perineal Procedures

These are the most common short procedures undertaken in the neonatal period. Umbilical hernia, Inguinal hernia, Hydrocele, Undescended testis, Torsion testis, Circumcision, Cystoscopy, PUV fulguration, and Colostomy [2].

36.4.1.1 Umbilical Hernias

Umbilical Hernias are common in newborns, especially in premature and low birth weight babies. The incidence is as high as 84% in newborns weighing 1000–1500 g, and 20% in those weighing 2000–2500 g. After separation of the umbilical cord, the umbilical ring undergoes spontaneous closure through the growth of the rectus muscles and fusion of the fascial layers. Delay or incomplete closure leads to herniation of the intra-abdominal contents through the open ring. Umbilical hernias are quite common in healthy neonates, but may be associated with some specific conditions, like autosomal trisomies (Trisomy 21 and 18), metabolic disorders (hypothyroidism, mucopolysaccharidoses), and dysmorphic syndromes (Beckwith-Wiedemann and Marfan syndromes). It is important to identify isolated umbilical hernia from that associated with syndromes with features like macroglossia or hypotonia, as a clue warranting further evaluation. Surgical repair of umbilical hernia in neonates is usually delayed due to its low complication rate and also because majority of umbilical defects close spontaneously within 2 years. Surgery is indicated for large defects (>1.5 cm) and in case of complications such as incarceration, strangulation, or rupture. Surgery is performed under general anesthesia.

36.4.1.2 Inguinal Hernia and Hydrocele Repair: Herniorrhaphy

Testicles are enclosed in a peritoneal covering, the processus vaginalis, which is usually closed at birth. Failure of closure leads to development of hernia and hydrocele. Obliteration of processus vaginalis occurs late in gestation, and so incidence of inguinal hernia is high in premature (10–11%) and extremely low birth weight (ELBW) (40%) newborns. Incidence in term newborns is less than 5%. Ten percent hernias in term and up to 50% in premature and ELBW babies are bilateral.

Hydrocele is a fluid collection that may occur anywhere along the path of testicular decent and may be communicating or noncommunicating. Parents usually bring the baby with a history of a painless **intermittent swelling** in the groin, which appears only on straining, e.g., during crying. Often, the hernia is **reducible**. At times, it cannot be reduced by manipulation and is termed as **incarcerated hernia**. Bowel within the hernia can become erythematous and trapped within the hernia sac and progress on to **bowel obstruction.** In females the sac may also contain an ovary.

The progressive swelling and edema of the entrapped contents of the hernia cause vascular compromise of the entrapped bowel, which becomes ischemic and progresses onto the stage of **strangulation.**

Unlike in adults, inguinal hernias are surgically corrected soon after diagnosis to prevent the risk of incarceration, strangulation, bowel obstruction, or gonadal damage. Management of hydrocele is more conservative and usually resolves within 1–2 years of life. Surgical correction is required if hydrocele persists beyond 1 year.

The definitive treatment for hernia is manual reduction followed by surgical repair. Major surgical issue with unilateral inguinal hernia is whether to explore the contralateral side or not, with the risk of damage to the vas deferens and spermatic cord. So, each neonate must be examined thoroughly for the presence of bilateral hernia, preoperatively.

Asymptomatic hernias can be electively scheduled at a later convenient date and time, but they remain at risk of incarceration, progressing onto intestinal obstruction, strangulation, and gangrene. Therefore, even asymptomatic hernias must be repaired at the earliest [3, 4].

Anesthesia

Unilateral inguinal hernia repair is a short procedure of about 30–45 min, while a bilateral repair may last up to 90 min. The goal of anesthetic management is rapid induction, rapid recovery, and good analgesia. Surgery is at the inguinal region, so muscle relaxation is not an issue, but adequate depth of anesthesia is a necessity for the hernial contents to be reposited into the abdomen. Either general or regional anesthesia can be used for inguinal herniorrhaphy. GA carries the usual risks of a newborn and neonate. Shorter-acting agents such as Sevoflurane with caudal or ilioinguinal/iliohypogastric nerve block or Fentanyl or Remifentanyl for pain relief are acceptable techniques, with face mask, or LMA, baby breathing spontaneously or assisted. Fluid and blood loss is minimal. In premature neonates, GA carries the usual risk of postoperative apnea and delayed recovery. Subarachnoid block (SAB) is advocated to avoid complications of GA. Baby movements can be controlled by gentle strapping or light anesthesia with O2 and Sevoflurane with a face mask [4].

Anesthesia for incarcerated or obstructed hernia: These neonates may be sick because of incarceration, obstruction, or gangrene of intestines. They may be hypovolemic, dehydrated, anemic, acidotic, hypoxemic, febrile, and oliguric. Surgery is prolonged and is associated with fluid shifts because of handling of intestines, chances of intestinal perforation or tear because of edema, and hemodynamic disturbances (hypotension and bradycardia). Blood transfusion may be needed in anemic babies and if there is blood loss. They are at risk of delayed recovery from anesthesia because of hypothermia, acid base, and electrolyte disturbances and may need postoperative ventilatory support. General anesthesia is the technique of choice, with muscle relaxation, tracheal intubation / LMA, and controlled ventilation, followed by reversal with neostigmine and glycopyrrolate at the end. Glycopyrrolate premedication reduces the risk of bradycardia at induction, laryngoscopy, intubation, and handling of the intestines. Intraoperative care includes monitoring for vitals, meticulous fluid therapy, maintenance of acid base and

electrolyte balance and calcium supplementation, and care to prevent reopening of intracardiac shunts. Postoperatively, babies must be under observation in the NICU, for at least 24–48 h, before shifting back to the ward., and discharge from hospital is usually delayed to 5–7 days depending on the intestinal handling.

In case of **gangrenous hernia**, after separation, intestines may need to be resected with colostomy usually done. Baby presents another time after 4–6 weeks for colostomy closure under anesthesia. General anesthesia with tracheal intubation and controlled ventilation is instituted, with facilities for postoperative ventilatory support and blood transfusion.

36.4.1.3 Undescended Testis: Orchidopexy

Orchiopexy is done for cryptorchidism in which there is a failure of normal testicular decent from abdomen into the scrotum. The undescended testicle may lie anywhere along its route of descent, within the abdomen, inguinal canal, or external ring. The incidence is 33% in preterm and 3% in full term males and reduces to 1% by 3 months of age. It is usually associated with a hernia. The chance for developing a malignancy is ten fold higher than in normal descended testes. It is not operated in the neonatal period, because of the risks involved in this age group, unless there is an emergency or there are indications for hernia surgery (see above).

Preoperative evaluation is important as there is high association of prematurity with undescended testes. One should look for various syndromes and cardiac defects and anatomical and physiological impact on anesthesia management, e.g., Noonan syndrome (congenital heart disease, bleeding problems, skeletal malformations, short neck, and small jaw), Prader Willi syndrome (muscle weakness, slow development, and usually not much problem in neonatal period), and cloacal exstrophy (OEIS syndrome – omphalocele, extrophy bladder, imperforate anus, and spinal defects).

The surgical procedure depends on the position of the testes. In babies requiring inguinal exploration, general anesthesia alone or in combination with a regional anesthesia can be used (Fig. 36.1). Anesthesia management is same as for inguinal

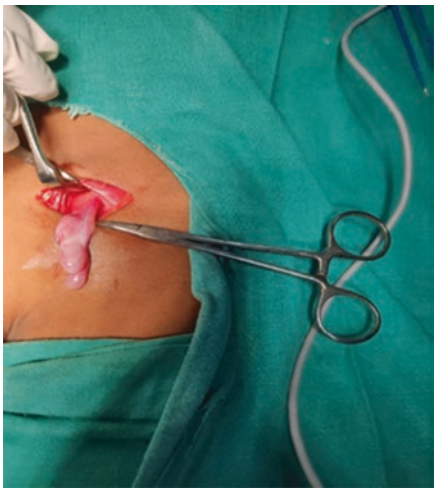

Fig. 36.1 Incision for undescended testis

herniotomy. Unlike hernia surgery, here tissue dissection may be more, which is painful. Multimodal analgesia including acetaminophen, NSAIDS, short-acting opioids, and regional techniques can be used. Regional analgesia can be provided by caudal route, or ilioinguinal or iliohypogastric nerve block. Ensure adequate depth of anesthesia especially when surgeon puts traction on the spermatic cord, foreskin, or testis, as this may trigger laryngospasm. A small IV bolus of propofol or increasing the inspired concentration of volatile anesthetic can prevent triggering of laryngospasm [5].

36.4.1.4 Torsion Testis

Testicular torsion is a true surgical emergency. Testicular torsion is either intrauterine or postnatal. The presentation of both is different, but sequels are same [6]. Prenatal torsion is generally associated with minimal or no findings, and if of long duration, it shows calcification and a hyper vascular ring of tunica with a hypodense center, while a short duration torsion shows mixed echogenicity. Antenatal sonography does not detect testicular torsion. Diagnosis is made at routine postnatal examination. Postnatal torsion is an acute manifestation with considerable swelling and tenderness of a previously normal testicle. Testicular infarction can occur within few hours of torsion; in addition, unilateral torsion can lead to bilateral testicular damage and infertility. Testicular torsion is best managed by early exploration, detorsion, and fixation. Testis should be salvaged as far as possible, and orchidectomy is done only if it is unsalvageable. Atrophic testis is a precursor of testicular carcinoma. Surgery is usually done under GA with RSI with caudal analgesia or under spinal anesthesia.

36.4.1.5 Circumcision

There are very few absolute indications for circumcision in neonates, but in a newborn with hydronephrosis, circumcision reduces the risk of urinary tract infections. Indications for circumcision are for (a) Religious and sociocultural reasons, and (b) Medical indications (true phimosis, balanitis xerotica, recurrent balanoposthitis, and urinary outlet obstruction). Neonatal circumcision is generally inexpensive, has low complication rate, and usually performed in the nursery under local anesthesia, like:

- Topically applied lidocaine-prilocaine cream,
- Subcutaneous ring block, or/and
- Dorsal penile block.

In case GA is required, it is same as described for other short procedures in this chapter. It is painful. Intraoperative analgesia can be provided with short-acting Fentanyl or dorsal penile block. Postoperative analgesia can be provided with acetaminophen, NSAIDs, and opioids coupled with regional anesthesia (penile block, pudendal nerve block, or caudal analgesia).

Note - LA without adrenalin should be used to avoid risk of ischemia and necrosis of glans penis.

Complications of circumcision include Infection, bleeding, meatal stenosis, and residual redundant skin.

36.4.1.6 Cystoscopy and Fulguration for PUV (Posterior Urethral Valves)

PUV is the most common cause of obstructive uropathy in children, incidence being 1/5000. The severity of renal changes from back pressure depends on the degree of obstruction and age of onset [5, 7]. Prenatal diagnosis can be made by fetal ultrasound, along with associated abnormalities, like bilateral hydronephrosis, oligohydramnios, and distended thick walled urinary bladder. A diagnosis in the second trimester is associated with poorer prognosis than those detected postnatal. Newborns with severe PUV may present with palpable bladder and anuria at birth. Postnatal diagnosis is established by voiding cysto-urethrogram (VCUG or MCU). Priority in all patients with PUV is early stabilization, and once the bladder is catheterized, it is no longer a surgical emergency.

Preoperative evaluation includes assessment of renal functions, urinary tract anatomy, extent of urinary retention and fluid overload, and evidence of renal failure. As far as possible, hypertension, azotemia, hyperkalemia, and hyponatremia should be optimized preoperatively. Azotemia affects branching of the bronchial tree and alveoli, and these babies may have respiratory compromise, evidenced with small chest and poor breathing movements, ascites, and limb deformities. Fetal urine forms the amniotic fluid. Underdeveloped kidneys and oliguria lead to oligohydramnios **(Potters Syndrome).** Fetus is not well cushioned from the uterine wall and assumes a typical facial appearance, the **Potter Facies.**

1. If **serum creatinine returns to normal after birth**, transurethral ablation of the valve leaflets under GA is undertaken.
2. If urethra is too small for the endoscope, then suprapubic vesicostomy and bladder exteriorization or catheterization are the only options, with ablation of valves at a later stage.

Inhalational or IV induction can be used. Procedure is performed in lithotomy position at the foot end of the OT table. The small baby is placed at the end opposite to the anesthesiologist and covered with drapes. This places the baby far away from the anesthetist. Hence, proper securing of airway is a must, either with an endotracheal tube or LMA. Use of short-acting relaxants and analgesics allows early recovery after the short procedure. A penile nerve block or caudal block can be given for intraoperative and postoperative analgesia. Judicious use of fluids and anesthetic agents is warranted in case of hydronephrosis and renal failure. Neonates with pulmonary hypoplasia may need postoperative ventilation.

36.4.2 Gastro Abdominal Procedures: Gastrostomy, Colostomy, Intraperitoneal Drain Placement

36.4.2.1 Gastrostomy

Gastrostomy (draining or feeding) is usually done in case of congenital deformities of the esophagus and small bowel (atresia), complicated TEF, exomphalos and CDH, for the purpose of gastric decompression, where definitive surgery cannot be

undertaken for various reasons. This has several benefits: improved ventilation, early enteral feeding, and patient comfort and better growth, allowing time for optimization before major surgery later, with better outcome. This is a short procedure, of 10–15 min duration, and can be performed under LA, with or without sedation, in the NICU itself.

36.4.2.2 Colostomy

Creation of colostomy is another common procedure in the newborn, often performed within 24–48 h of birth, on urgent basis in NEC, anorectal malformations, Hirschsprung's disease, and imperforate anus.

1. **Imperforate anus** can present as a simple membranous defect to more complex involving urogenital anomalies. The newborn will present with non-passage of stools in the first 24 h, abdominal distention, or passage of stools near the penis, scrotum, or vagina from a fistulous connection.
2. **Anorectal malformations:** The incidence of anorectal malformations is 1 in 5000 newborns and may be associated with other congenital abnormalities such as VACTERL (Vertebral, Anal, Cardiac, Tracheal Esophageal, Renal, and Limb) and REAR (Renal, Ear, Anal, and Radial) syndromes. Preoperatively, babies should be screened for these anomalies, and due care taken during surgery and anesthesia.
3. **NEC** is a common surgical diagnosis in very sick neonates. Definitive surgery includes exploratory laparotomy, gut resection, and anastomosis or exteriorization. These babies are very sick and the surgery carries a high mortality. Hence, colostomy is often undertaken to allow time for the baby to optimize and reduce the risk of surgery, in very sick and premature newborns. Extensive abdominoperineal repair (APR) is undertaken later when the baby is about 3 months old, and when risk of anesthesia and surgery is considerably low.

Anesthesia Technique

Surgical management may be a simple perineal anoplasty (cut in the covering membrane) or a loop or divided colostomy (Fig. 36.2). Usually when the baby presents

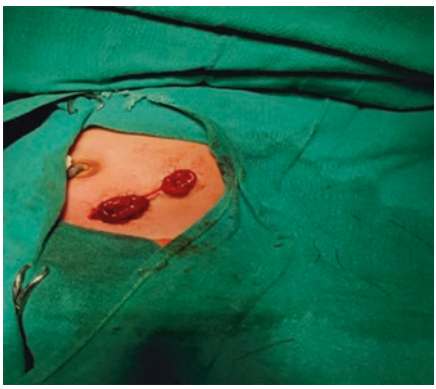

Fig. 36.2 Colostomy – the two exteriorized ends of the descending colon

for anesthesia, an orogastric tube for stomach decompression is already in place. Before induction of anesthesia, its patency and proper placement must be checked and if any doubt it should be replaced, and stomach contents aspirated with a low pressure suction, or a syringe. GA with modified RSI, tracheal intubation with controlled ventilation, is the preferred technique. Nitrous oxide should be avoided at induction, to prevent further bowel distention and hemodynamic decompensation. For intraoperative analgesia, short-acting IV narcotics or caudal epidural can be used. A continuous caudal technique allows for postoperative analgesia too. Rectal suppositories cannot be used in these cases, but IV paracetamol can used to supplement postoperative analgesia. There may be large insensible and third space fluid losses associated with bowel handling and manipulation, so hydration and intravascular volume should be maintained. Blood loss is usually not significant to warrant transfusion. Babies can be extubated on the table and kept under observation in the NICU.

36.4.2.3 Intraperitoneal Drain (PD) Placement

Peritoneal drain is generally used as the initial management of intestinal perforation in premature neonates. Placement of an intra-abdominal PD relieves the acute respiratory and circulatory physiological effects of tension pneumoperitoneum, thus giving time for optimization of patient for definitive repair. It is generally done as a bedside procedure in the NICU under local anesthesia.

36.4.3 Tracheostomy

Tracheostomy is done for the maintenance of airway in neonates with neurologic impairment, pulmonary insufficiency, and acute airway obstruction, needing to be on prolonged ventilatory support [8, 9]. Common specific conditions are:

1. **Respiratory distress syndrome (RDS)**, very common in premature newborns, necessitating ventilatory support right from the time of birth. Duration of ventilatory support or assistance depends on the degree of lung maturity.
2. **Upper airway obstruction** is an absolute indication for tracheostomy. Proximal lesions such as Pierre Robin Syndrome and craniofacial abnormalities cause obstruction at the level of nasal and oral cavities, whereas subglottic stenosis, laryngomalacia, vocal cord paralysis, cysts, lymphangiomas, and hemangiomas cause obstruction at the level of larynx. Damage to the airway from trauma or infection may also need short-term tracheostomy.

Tracheostomy in newborn is a complex procedure due to anatomical and technical factors. Neonatal tracheostomy tubes (TT) are shorter than the pediatric TT and are usually uncuffed, but cuffed tubes are occasionally used in neonates requiring high ventilation pressures, as in RDS.

Technical issues in neonates: Trachea is small, pliable, and difficult to palpate in the short neck, more so in preterm and ELBW newborns. Pleura extends into the

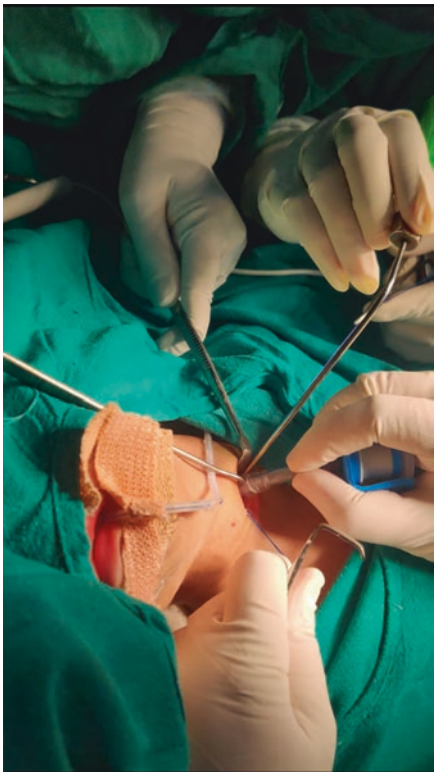

Fig. 36.3 Transverse tracheostomy

neck which poses the risk of pleural damage. Unlike in children, a vertical tracheostomy is preferred in neonates to avoid the risk of subglottic stenosis associated with a transverse tracheostomy (Fig. 36.3), but it poses a difficulty at the time of change of blocked or dislodged TT, until stoma maturation is complete.

The procedure is undertaken in the operation theatre. Most babies already have an endotracheal tube (ETT) in situ. Often an emergency tracheostomy is performed when such babies present for other surgeries with no apparent respiratory difficulty. Problems are encountered at the time of induction of GA, laryngoscopy, and intubation, when anesthetist fails to pass in even the smallest size ETT or causes injury to the upper airway with repeated attempts at intubation.

Preoperative assessment must include history of difficult mask ventilation, difficulty in securing the airway, and last feed time. At least 3 h should elapse from the last feed to avoid risk of regurgitation, vomiting, and pulmonary aspiration. Those with history of difficult laryngoscopy and intubation should have a backup plan at the completion of tracheostomy, like leaving an airway exchange catheter in the trachea during withdrawal of ETT, with the care that the tip is between the vocal cords so that ETT can be reinserted easily if need arises (as in failure of introducing TT).

Anesthesia Technique

In neonates with ETT in situ, tracheostomy can be done as an elective procedure, after initial stabilization. Anesthesia considerations and technique is as for any other airway surgery.

Babies who present for tracheostomy without ETT pose a greater challenge. It is important to maintain oxygenation and hemoglobin saturation within the normal range, using a face mask. Attempt should be made to secure the airway by intubation. In case of difficulty or failure to intubate, procedure can also be performed under LMA. Short-acting muscle relaxants and analgesics are preferred to allow early recovery without respiratory depression or compromise. It can also be performed with the baby breathing spontaneously, a mixture of O_2, air/N_2O, and sevoflurane, while surgeon instils LA at the incision site.

Postoperatively, babies must be cared for in NICU for postoperative ventilatory support, with maintenance of temperature, respiration and gas exchange, and analgesia. Feeding can be started after 3 h if there are no complications and bleeding.

36.4.4 Infective (Drainage, Debridement): Necrotizing Fasciitis (NF), Septic Arthritis

36.4.4.1 Necrotizing Fasciitis (NF)

NF is a rare life-threatening infection of the soft tissue, with fatal sequel. Bacterial invasion of the subcutaneous tissue releases endotoxins and exotoxins causing tissue ischemia and liquefactive necrosis. Accompanying systemic inflammation increases the morbidity. Mortality can be as high as 57% [10]. Cause of death is septic shock, DIC, and/or multiorgan failure [10]. Risk factors for NF in neonates include immunodeficiency, malnutrition, omphalitis, mammitis, balanitis, septicemia, NEC, fetal scalp monitoring, bullous impetigo, postoperative, diaper rash, burns, insect bites, hematologic malignancies, or nephrotic syndrome [10–12]. In as many cases no underlying diseases or triggering factor may be found. Even a small wound of capillary sampling site may provide entry point for the bacteria and can occur anywhere in the body (Fig. 36.4).

Fig. 36.4 NF on inner thigh in a neonate

Presenting Features
Initial symptoms are nonspecific like fever, tenderness, erythema, pain, and edema, which may extend beyond the erythematous border since underlying tissue damage is much more extensive. If untreated, fulminant progression can occur within hours, with erythema progressing to violaceous necrotic lesions, vesicles, and bullae. **Primary NF** is monomicrobial and common in the lumbar area, while **secondary NF** is polymicrobial and common over the abdominal wall [10].

"Pain out of proportion" a typical sign in adult NF, but is not obvious in the neonate. Typical surgical findings are loose nonadherent fascia that gives away to blunt dissection and local edema (dishwater fluid) due to subcutaneous tissue necrosis which is gray non-bleeding. Once suspected, microbiological sampling is done and antibiotics started. Management is usually supportive. Surgical debridement of all necrotic tissue and drainage of affected fascial plane by fasciotomy improve the chances of survival.

Preoperative evaluation includes CBC, blood sugar, and coagulation profile. Neonates are anemic, with leukocytosis, abnormal coagulation profile, and hyper or hypoglycemic. Hemodynamic parameters must be optimized prior to surgery. All IM or SC injections must be avoided. Wound debridement is done under GA with controlled ventilation and good analgesia as it is very painful. There can be massive fluid and blood loss. Aggressive fluid therapy and fresh blood transfusion are needed. Blood sugar must be monitored and maintained in normal range. Urine output must be maintained at least 0.5–1 mL/kg/h, to preempt renal dysfunction.

36.4.4.2 Septic Arthritis

Septic arthritis is difficult to diagnose, particularly of deeper joints. The risk factors include umbilical catheterization, breech presentation, prematurity, sepsis, perinatal asphyxia, TPN (total parenteral nutrition), femoral venipuncture, and birth trauma [13, 14]. Delay in diagnosis can have potentially devastating sequelae: -

1. Pathologic joint instability,
2. Avascular necrosis,
3. Epiphyseal separation, or Premature epiphyseal closure,
4. Growth disturbance leading to limb length inequality, and.
5. Premature arthritis from joint destruction.

Neonates may be afebrile and have normal laboratory values, as TLC, ESR, and C-reactive proteins due to inappropriate immune response. Diagnosis is often delayed, increasing the risk of a poor outcome. The common presenting features are irritability, poor feeding, tenderness, limited range of motion, local swelling, difference in resting position of the affected extremity, erythema, warmth, and instability of the joint. Various imaging modalities can aid in the diagnosis of septic arthritis such as X Rays, USG, and MRI. USG is particularly useful as it can confirm joint effusion and identify periosteal separation or sub-periosteal collection, and cortical erosion. Treatment options include IV antibiotics with serial aspirations or surgical incision and drainage (I & D) as bedside procedure. Most important is to maintain

asepsis and is best done in the OT under GA or regional anesthesia. Needle aspiration is a short procedure and can be done under LA and sedation and O_2, N_2O, sevoflurane inhalation by face mask. I & D procedure requires a still baby and is a slightly prolonged painful procedure. Usually, GA/IV induction and SGD/LMA suffice with baby breathing spontaneously, along with IV or caudal analgesia.

36.4.5 Birth Injuries (BI) and Neonatal Care Injuries (NCI)

Bi and NCI are causes of concern because of their contribution to neonatal morbidity and mortality. They contribute to nearly 2% mortality of all neonatal deaths.

36.4.5.1 Birth Injuries (BI)

Babies usually present within first 24–72 h of life. Earlier incidence of 2–7% of all deliveries (vaginal and operative) is on the decline with improvement in obstetric care [15, 16]. Many injuries can be managed conservatively such as **caput succedaneum, cephalic hematoma, minor intracerebral bleeds, fractures (clavicle, humerus, femur, slipped humerus epiphysis), shoulder or hip dislocation, and rib fracture** (following aggressive resuscitation) by splinting, bandaging, or POP, unless thoracic viscera is injured and bleeds. **Splenic rupture** is a serious condition. It occurs at during delivery, in babies with splenomegaly with associated coagulation disorders, vascular malformations, or hemangiomas. This is a surgical emergency. Baby becomes symptomatic and hemodynamically unstable within 24 h due to intra-abdominal bleeding, needing aggressive fluid and blood resuscitation, vasoactive drug infusion, and intubation and respiratory support for maintenance of oxygenation. The perioperative risk is high because of splenomegaly related abnormalities, hypothermia, need for large volume fluid and blood transfusion, and adverse outcomes. GA with ETT and controlled ventilation is adopted. Adequate analgesia must be provided. All care, monitoring, and precautions must be taken as in any newborn undergoing major emergency surgery. Postoperative ventilatory support for 12–24 h or till the baby becomes hemodynamically stable improves the outcome.

36.4.5.2 Neonatal Care Injuries (NCI)

These injuries occur during neonatal care, and usually present by 1–2 weeks, more commonly in premature babies in NICU than in home care [15]. Minor injuries, like **bruises or puncture marks, caustic burns from chemicals** used on the skin, and **fractures,** are managed conservatively. A common NCI is **finger-tip necrosis** following a tight SpO_2 monitor clip, leading to finger pulp amputation. **Cautery burns** usually heal with minor scarring. **Gastric perforation,** spontaneous, or due to prematurity, nasal ventilation at high pressures, sepsis, and steroid therapy, though rare, is usually fatal. Once diagnosed, it is a surgical emergency. GA is administered with standard care and precautions. Hyponatremia is a medical emergency. **Vascular life threatening conditions, like thrombosis, thromboembolism, vasospasm, vessel**

tear, and bleeding, need urgent management and are secondary to multiple attempts at IV or arterial cannulations. **Thrombosis** is managed conservatively by removal of catheter and anticoagulant and antifibrinolytic therapy. Surgical thrombectomy is not attempted because of high risk of GA and small size of the vessels.

36.4.6 Ventriculoperitoneal (VP) Shunt Placement

Hydrocephalus, accumulation of CSF in the skull, occurs because of obstruction to flow of CSF or due to excessive CSF production [17, 18]. Conditions associated with hydrocephalus are:

- **Inborn or Congenital** - Arnold-Chiari malformation, Dandy Walker syndrome,
- **Acquired** - brain tumors, intraventricular hemorrhage (IVH), infection, trauma.

36.4.6.1 Neuroanatomy and Physiology

The duramater is covered by the calvaria consisting of ossified plates connected by fibrous structures and fontanelle at the joints. This makes the skull of a newborn more compliant, so that with increase in CSF volume, though the skull /head will expand, there will be no increase in ICP. Presenting features are vague such as irritability, poor feeding, and lethargy. Parents notice disproportionate increase in head circumference, expanding sutures, bulging fontanels, "sundowning" of the eyes, and lower motor neuron deficit (weakness in the lower limbs).

Neonatal neurophysiological differences affect the management of intracranial hypertension. Normally, ICP in the neonate is low (2–4 mmHg) compared to that in adults (8–15 mmHg). The cerebral autoregulation limit is significantly lower with a MAP of 20–60 mmHg. This is inefficient in premature babies and in the presence of a pathological process. The global cerebral blood flow (CBF) is lower than that in children and adults. Large acute fluctuations in systemic blood pressure are poorly tolerated as systemic hypertension may cause IVH, while low mean arterial pressure may result in cerebral ischemia. The response to hyperventilation is exaggerated and ischemia may ensue at low $PaCO_2$ levels (<20 mmHg) due to intense cerebral arterial vasoconstriction. Untreated hydrocephalus is a cause of poor neurologic outcome due to ventriculomegaly, ischemia, and irreversible cellular damage.

Surgery aims at increasing CSF drainage, by making an alternative CSF flow path from the ventricular system to the **peritoneum (VP), pleural cavity, or right atrium.** A definitive procedure, removal of obstruction, is a major procedure, which is undertaken when the baby is mature enough to tolerate the cranial surgery.

Among the drainage procedures, **VP shunt** is the most common in neonates, with least risk. Complications include repeated blockage, infections, leaks, and over drainage from the valve failure, requiring frequent revision surgeries, on semi-emergency basis. In a near-term and full-term newborn with post-hemorrhagic hydrocephalus where surgical shunt is contraindicated, a ventricular assist device can be placed under LA at the bedside [19].

Anesthetic Considerations

Anesthetic management presents several challenges due to associated anomalies, prematurity, and associated comorbidities (Low birth weight, Anemia, Coagulopathy, Jaundice, RDS, and PFC), and distortion of airway anatomy by macrocephaly.

Preoperatively, baby should be assessed for coexisting diseases, medications, IV volume status, previous anesthetic history, evidence of raised ICP, vomiting and electrolyte imbalance, hormonal alterations, and seizures and anticonvulsant therapy (which need to be continued). Altered mental status or underlying pulmonary pathology may require preoperative blood gas analysis and postoperative airway and ventilatory support.

Preoperative sedatives should be used cautiously as indiscrete use can cause respiratory depression, altered sensorium, and further increase in ICP. Midazolam may be given orally. Ketamine is contraindicated as it increases CBF, ICP, cerebral metabolic rate, and O_2 consumption and lowers seizure threshold. GA with ETT and controlled ventilation is the technique of choice. IV induction with thiopentone (5–7 mg/kg) is preferred. Inhalational induction with sevoflurane is one if there is no IV access. Volatile anesthetics cause cerebral vasodilation and increase in ICP. Sevoflurane and Isoflurane have minimal effect on CBF, ICP, and cerebrovascular reactivity to CO_2 at low MAC (0.5–1.5).

Positioning at induction is challenging as macrocephaly distorts the normal skull anatomy and makes airway difficulty. The large occiput places the neck in extreme flexion, and large forehead obscures the line of sight during laryngoscopy or increase ICP due to jugular vein occlusion impeding venous drainage. A roll of towel placed under the shoulders can ease the airway difficulty, laryngoscopy, and intubation. A modified RSI is indicated as these babies are at risk for aspiration. The eyes should be adequately padded to protect from drying and injury (Fig. 36.5).

A short-acting opioid (fentanyl, remifentanil) will provide adequate intraoperative analgesia, allowing for rapid emergence and permitting timely postoperative neurologic assessment.

Because of the large head and its exposure during shunt placement, these neonates are prone to heat loss, **hypothermia,** and related sequel as peripheral vasospasm, increased O_2 consumption, metabolic acidosis due to increased lactate production, shift of the ODC to Left, decreased hepatic drug metabolism, delayed emergence from anesthesia, coagulopathy, immunodeficiency, hypoglycemia, and arrhythmias. Intraoperative temperature monitoring is crucial.

0.9% saline (NS) is commonly used as IV fluid for VP shunt surgery. It has slight hyperosmolarity (308 mOsm) which may attenuate cerebral edema. Neonates are at higher risk for hypoglycemia and must receive dextrose containing IV fluids (N/5). Hyperglycemia should be avoided as it can lead to cerebral ischemia and brain injury.

Nonsurgical measures (pharmacotherapy) to reduce raised ICP include:

1. Furosemide (loop diuretic),
2. Mannitol (osmotic diuretic), and
3. Hypertonic saline (3%).

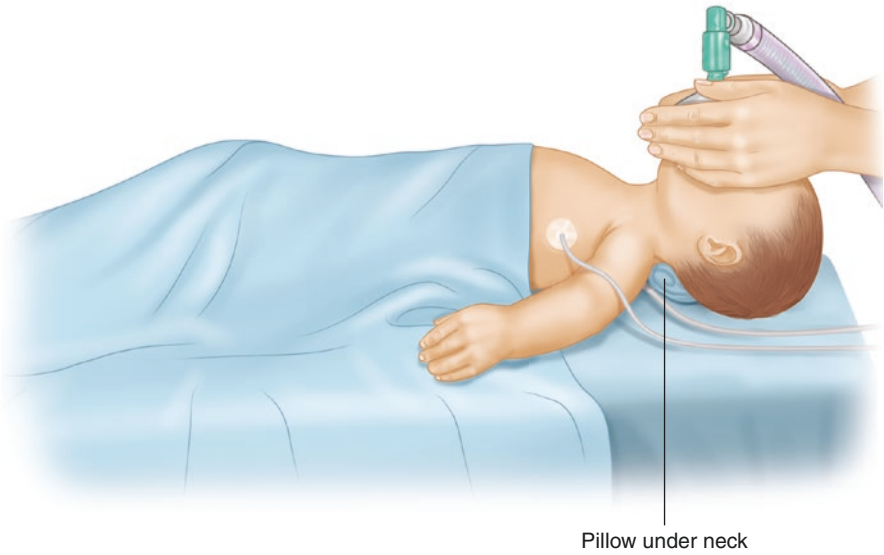

Fig. 36.5 Position at induction for VP shunt

These babies are at risk of delayed recovery and apnea, hence need postoperative monitoring.

36.5 Conclusion

Even for short minor procedures, the principles of anesthetic management and perioperative care remain same as for any major procedure including temperature control, glucose management, positioning, blood loss, meticulous fluid administration, maintenance of volume status, and vigilant monitoring. Difference in airway, respiratory, and cardiovascular anatomy, physiology, pharmacology, drug metabolism and excretion, and immature hepatorenal function are important considerations during anesthetic management.

The management of neonates with severe illness or major anomalies is challenging. Equally, or rather more challenging is when these babies undergo minor short procedures, because the anesthetic considerations, risks, and complications are same as in any other neonate, but with demand of quick induction and rapid recovery, without need for postoperative ventilatory support or other complications.

GA with IV or inhalational induction, LMA for airway control, and spontaneous respiration is most often appropriate. Endotracheal intubation is done only if indicated because of the risks associated with it. Preoperative evaluation should be as detailed, and with proper planning, and adequate knowledge of newborn and neonatal physiology, one can achieve good outcome after anesthesia. Basic care includes noninvasive vital monitoring, thermo neutral environment, meticulous fluid

replacement (risk of overhydration), and readiness for management of any complication or critical event. Anesthesiologist and other OT staff must be well-trained in caring for neonates. If detected and managed early, morbidity and mortality related to short procedures under GA in the neonates can be minimized.

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