Indian Journal of Clinical Anaesthesia 2025;12(4):720–725

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Indian Journal of Clinical Anaesthesia

Journal homepage: www.ijca.in

Case Series

Anaesthetic challenges in paediatric reconstructive surgery for obstetric brachial plexus palsy: A retrospective case series

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Abstract

Background: Obstetric brachial plexus palsy (OBPP) is an injury to the C5-T1 nerve roots of the brachial plexus due to traction during delivery. While some cases resolve spontaneously, others require surgical intervention. Anaesthetic management in these cases can be challenging, especially in infants and young children undergoing reconstructive procedures.

Objective: To evaluate the anaesthetic strategies and challenges encountered in the perioperative management of paediatric patients undergoing various surgical corrections for OBPP.

Materials and Methods: A retrospective analysis was conducted on 10 paediatric patients diagnosed with OBPP who underwent reconstructive surgeries at a tertiary center. Surgical procedures included nerve grafting, tendon transfers, muscle releases, and Botox injections. Data collected included demographics, type of surgery, anaesthetic technique used, intraoperative monitoring, airway management, use of regional anaesthesia, and perioperative complications.

Results: Patient-tailored anaesthetic approaches were planned according to age and the surgical procedure. General anaesthesia with endotracheal intubation was used in all patients. Regional anaesthesia was selectively applied depending on the surgical site for analgesia. Intraoperative considerations included avoiding muscle relaxants during nerve stimulation, maintaining normothermia, and using total intravenous anaesthesia (TIVA). No major anaesthetic complications were reported. All patients had an uneventful recovery.

Conclusion: Anaesthetic management in OBPP surgeries requires meticulous planning, individualized techniques, and multidisciplinary coordination. Understanding the specific challenges posed by paediatric neuro-reconstructive surgery helps optimize outcomes and minimize risks. Our case series reinforces the importance of tailored anaesthetic protocols and highlights the safety of current practices when implemented with caution.

Keywords: Nerve stimulator, Obstetrical brachial plexus palsy, Paediatric anaesthesia, Paediatric orthopaedic surgery, TIVA.

Received: 21-07-2025; **Accepted:** 21-10-2025; **Available Online**: 31-10-2025

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1. Introduction

Obstetric brachial plexus palsy (OBPP) is an injury to one or more of the trunks (C5-T1) of the brachial plexus. The condition develops during childbirth and may involve the whole or part of the upper extremity, resulting in complete paralysis or limited active motion due to mechanical injury to the brachial plexus nerves.[1] The most frequent form involves the C5 and C6 nerve roots (upper plexus or Duchenne-Erb palsy), which manifests with functional impairment of the shoulder, followed by involvement of the upper and intermediate plexus (C5-C7).[2,3]

The incidence of OBPP is 2.9 per 1000 live births, with the incidence of persistent OBPP being 0.46 per 1000.[4] In the literature, spontaneous recovery occurs in over 90% of

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https://doi.org/10.18231/j.ijca.12462.1761131735

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cases.[5-7] Various surgical management options are available based on the extent of injury and the potential for postoperative recovery.[8] Anaesthetic management can be particularly challenging in patients undergoing exploration with or without nerve grafts during microsurgical reconstructions. Non-explorative corrective surgeries generally require standard anaesthetic techniques with conservative management. The goal of surgery is to optimize hand function at the earliest possible age. This case series presents a retrospective analysis of 10 paediatric patients with OBPP scheduled for various reconstructive surgeries.

2. Materials and Methods

A retrospective analysis of 10 paediatric patients with obstetric brachial plexus palsy (OBPP) who were scheduled for various reconstructive surgeries was conducted at a tertiary center. Data were collected from August 2022 to July 2024. A variety of corrective procedures were proposed based on the level and extent of injury to the plexus. The surgical procedures included explorative surgeries with or without nerve grafting and non-explorative procedures such as botulinum toxin injection, Minimally Invasive Subscapular Release (MISR) with Conjoint Tendon Transfer (CTT), and derotation osteotomy.

After obtaining informed written consent from the parents, 10 children with OBPP, classified as ASA grade I and II, were included in the study. Consent to publish the data was also obtained from the parents. The demographics, gender, and procedure details are elaborated in the **Table 1**.

Out of the ten patients, one required botulinum toxin injection, and two required Minimally Invasive Subscapular Release with Conjoint Tendon Transfer (MISR with CTT). These non-explorative procedures required conventional general anaesthesia using a micro-cuffed endotracheal tube as the airway device, with atracurium as a muscle relaxant (with time-bound doses) and isoflurane for maintenance of anaesthesia. Standard monitoring techniques according to the American Society of Anaesthesiologists (ASA) were used for these patients. Both intraoperative and postoperative periods were uneventful (**Table 2**).

Table 1: Patient demographics and procedures

Patient No.	Age & Weight	Sex	Procedure	Anaesthesia
1	9 months/ 6 kg	F	Exploration + Repair	GA + CV + ETT (4 mm)
2	11 months / 7 kg	F	Exploration + Grafting	GA +CV +ETT (4 mm)
3	8 months / 7 kg	M	Exploration + Grafting	GA +CV +ETT (4 mm)
4	17 months / 10 kg	F	Exploration + Repair	GA +CV +ETT (4 mm)
5	6 months / 7 kg	M	Exploration + Grafting	GA +CV +ETT (3.5mm)
6	48 months/13kg	M	Botulinum Toxin injection	GA +CV +ETT (4.5mm)
7	12 months/10 kg	M	Exploration+ Repair	GA + CV + ETT(4mm)
8	12 months/6.5 kg	F	Exploration + B/L Sural Nerve Grafting	GA +CV +ETT (3.5mm)+ caudal block
9	36 months/ 10kg	F	MISR + CTT	GA + CV + ETT(4mm)
10	48 months/12 kg	F	MISR + CTT	GA + CV + ETT(4.5mm)

Kg: Kilogram; mm: Millimeter; F: Female; M: Male; GA: General Anaesthesia; CV: Controlled ventilation; ETT: Endotracheal tube; B/L: Bilateral; MISR: Minimally invasive subscapular release; CTT: Conjoint tendon transfer

Table 2: Anaesthesia plans (Grouped by Type)

No. of Cases	Procedure Context	Anaesthetic Plan
1 case	Botulinum toxin injection	Conventional GA + Controlled Ventilation + Propofol + Atracurium + Isoflurane
2 cases	MISR with CTT	Conventional GA + Controlled Ventilation + Propofol + Atracurium + Isoflurane
1 case	Explorative surgery with Sural Nerve Grafting	Conventional GA + Controlled Ventilation + Atracurium for intubation + TIVA (Dexmedetomidine +1% Propofol+ caudal analgesia
3 cases	Explorative surgery with repair	Conventional GA + Controlled Ventilation + Atracurium for intubation + TIVA (Dexmedetomidine +1% Propofol)
3 cases	Explorative surgery with nerve grafting	Conventional GA + Controlled Ventilation + TIVA (Dexmedetomidine +1% Propofol) No Relaxant

TIVA: Total intravenous anaesthesia; GA: General anaesthesia; MISR: Minimally invasive subscapular release; CTT: Conjoint tendon transfer.

Among the remaining seven patients, three underwent explorative surgeries, and four underwent explorative procedures with nerve grafts. The nerve grafts used included the suprascapular nerve (SSN), spinal accessory nerve (SAN), and sural nerve. For these explorative procedures, surgeons preferred general anaesthesia without muscle relaxants during intraoperative nerve stimulation. Direct nerve stimulation was used to detect motor nerves and differentiate the nerve from surrounding tissues in cases of disturbed anatomy due to brachial plexus trauma. Cable nerve autografts were fixed using "nerve glue". Consequently, general anaesthesia with total intravenous anaesthesia (TIVA) was administered.[9] The agents used included 1% propofol and dexmedetomidine. Propofol was infused via Target Controlled Infusion (TCI) pumps (plasma level 3 mcg/kg/hour to 5 mcg/kg/hour) and as a manual infusion pump (5 to 6 mg/kg/hour).[10] Since propofol is not an analgesic, dexmedetomidine was infused at 0.3 to 0.5 microgram/kg/hour. Both infusions were stopped 30 minutes prior to skin closure. Adequate depth of anaesthesia was maintained and monitored using Bispectral Index (BIS) or Entropy. Intraoperative blood loss was less than 10% of total blood volume for each patient, and no blood or blood transfusion were required.

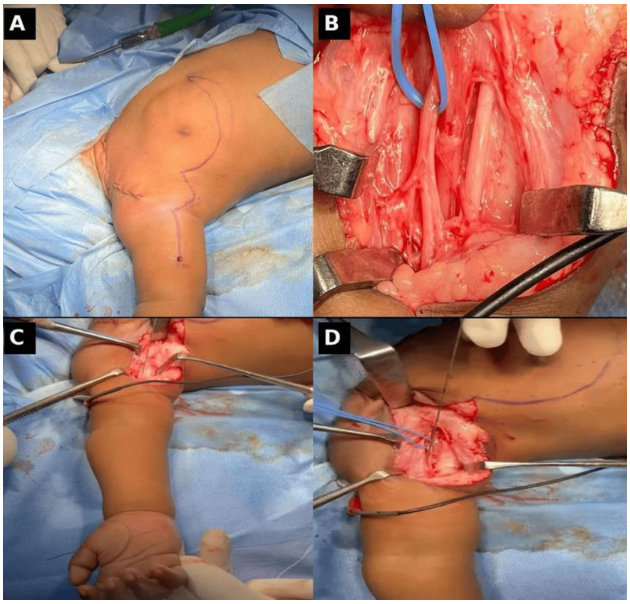


Figure 1: Images showing intraoperative nerve isolation and stimulation; **A):** Surgical site showing marking for skin incision; **B):** Nerve components of the plexuses isolated from surrounding structures; **C):** Appropriate motor response observed during stimulation; **D):** Sterile Stimuplex needle used to elicit response

For one patient requiring bilateral sural nerve grafting, postoperative analgesia was provided using a caudal block with 0.1% levobupivacaine at 1 ml/kg, as the site for the donor graft was decided intraoperatively. Fluid management was based on the Modified Holiday Segar formula, and dextrose was administered only to patients whose capillary blood glucose was less than 60 mg/dL. Maintaining intraoperative normothermia in explorative procedures was challenging due to the longer duration of surgery and the larger skin surface area exposed to access cable nerve grafts intraoperatively (**Figure 1**). Bair Hugger warming blankets and hotline fluid warmers were used to maintain normothermia.

All patients who underwent explorative procedures with total intravenous agents had uneventful recoveries, with no incidences of spasm during extubation or delayed recovery. All 10 patients were subjected to shoulder spica cast application prior to extubation postoperatively.

3. Results

The study involved 10 patients aged from six months to four years, with weights ranging from 6 kg to 13.5 kg. The details regarding the type of procedure performed and the anaesthesia administered have been described earlier (**Table 2**). Gender distribution showed that six out of the 10 patients were female (**Figure 2**). The average age of the patients in the study was 20.7 months, the average weight was 8.85 kg, and the average duration of non-explorative procedures was 115 minutes, while explorative procedures took an average of 394 minutes (**Table 3**).

Intraoperative nerve traction and stimulation emphasized the need for stable anaesthesia to allow accurate nerve monitoring.[11] The anaesthetic plans used in different procedures are categorized in (**Figure 3**).

Table 3: Patient characteristics

Characteristic	Value
Total Patients	10
Mean Age (months)	20.8
Mean Weight (kg)	8.85
Female/Male	6/4
ASA Grade I / II	8 / 2
Explorative Procedures	7
With Nerve Grafts	4
Non-Explorative Procedures	3
TIVA with Propofol + Dexmedetomidine	7
Post-op Caudal Block	1
Intra-op Blood Loss >10%	0
Post-op Complications	None

Kg: kilogram; ASA: American Society of Anaesthesiology; TIVA: Total Intravenous Anaesthesia; Post-op: Postoperative; Intra-op: Intraoperative

Variable	Value
Age (months) SD	Mean 20.8
Weight (kg)	Median 8.85
Sex (F/M)	6/4

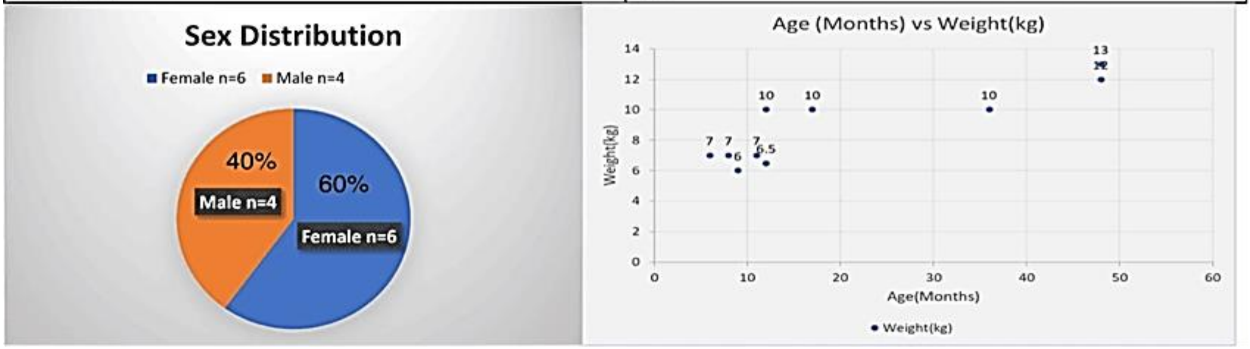
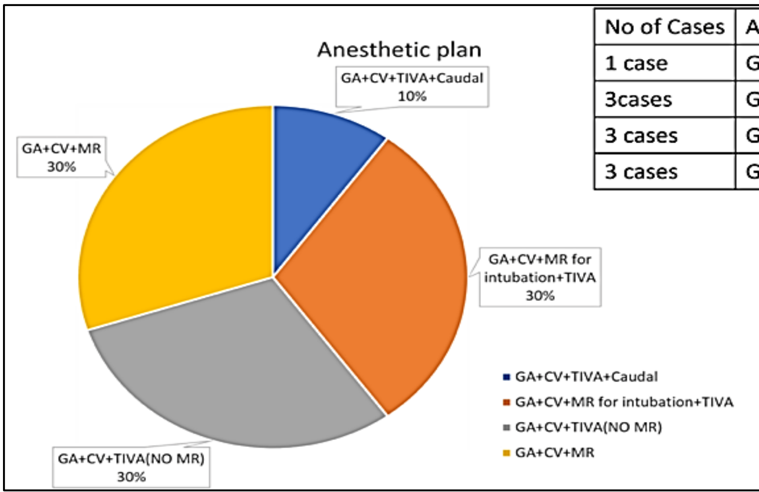


Figure 2: Age-wise, weight-wise and gender-wise distribution



No of Cases	Anesthetic plan
1 case	GA+CV+TIVA+Caudal
3cases	GA+CV+MR for intubation+TIVA
3 cases	GA+CV+TIVA(NO MR)
3 cases	GA+CV+MR

GA: General anaesthesia; CV: Controlled ventilation; MR: Muscle relaxant (Atracurium); TIVA: Total intravenous anaesthesia

Figure 3: Graphical representation of anaesthetic plan

4. Discussion

Reconstructive procedures for Obstetric Brachial Plexus Palsy (OBPP) can involve either explorative surgeries with or without nerve grafts or non-explorative surgeries, as discussed earlier. The main anaesthetic challenge arises during explorative surgeries, particularly when avoiding the use of muscle relaxants and inhalational agents. This is necessary to ensure accurate nerve stimulation and avoid aberrant results during intraoperative nerve monitoring.

For these procedures, propofol and dexmedetomidine were used to maintain the depth of anaesthesia. Propofol, an intravenous hypnotic agent, is commonly used for the induction and maintenance of sedation and general anaesthesia. It works by potentiating the inhibitory neurotransmitter γ-aminobutyric acid (GABA) at the GABAA receptor, leading to its widespread use due to its favorable pharmacokinetic and pharmacodynamic properties, such as rapid onset and short duration of action.[12]

The use of Target Controlled Infusion (TCI) pumps, specifically the Paedfusor model, was a key element in maintaining a consistent anaesthetic depth in paediatric patients. The Paedfusor model was chosen because it is designed specifically for paediatric patients and considers variables such as age, weight (5 to 60 kg), and other factors that influence drug metabolism.[13] This model ensures a more accurate target plasma concentration, which for this study was set between 3 and 5 micrograms/kg/hour.[10] The other model used in paediatric patients is Kataria.[14] For patients younger than one year, where the Paedfusor model wasn't applicable, manual infusion of 1% propofol at 5 to 6 mg/kg/hour was used to maintain anaesthesia.[15] The use of propofol helped reduce the incidence of postoperative nausea and vomiting (PONV) and emergence delirium, which are common concerns in paediatric anaesthesia.[16] The use of Target Controlled Infusion (TCI) pumps, specifically the Paedfusor model, was a key element in maintaining a consistent anaesthetic depth in paediatric patients.

A critical consideration with propofol use in paediatric anaesthesia is its context-sensitive half-life, which is longer in children than in adults.[17] The average duration of propofol infusion in our study was 334.28 minutes for the seven patients receiving propofol. Importantly, propofol infusion was stopped 30 minutes before the closure of the skin to allow for an appropriate emergence from anaesthesia.

One drawback of propofol is the pain associated with intravenous infusion, especially in smaller veins. This can be mitigated by ensuring wide-bore peripheral venous access and preemptively administering intravenous lidocaine (0.2 to 0.5 mg/kg), which reduces the discomfort typically experienced during propofol infusion.

In addition to propofol, dexmedetomidine, a selective α2-adrenergic receptor agonist, was used to supplement anaesthesia.[18] Dexmedetomidine offers several advantages in paediatric anaesthesia, including its ability to provide arousable sedation without significant respiratory depression. This makes it particularly useful in paediatric neuro-reconstructive surgeries where airway patency and respiratory drive are critical.[19] The infusion rate was maintained at 0.3 to 0.5 micrograms/kg/hour using manual pumps. Dexmedetomidine's opioid-sparing effects are another significant benefit, helping to reduce the need for opioid analgesics, which are often associated with undesirable side effects such as constipation and respiratory depression.

The combination of propofol and dexmedetomidine allowed for the maintenance of a stable anaesthetic plane while minimizing the need for muscle relaxants, which could interfere with nerve monitoring during surgery. Intraoperative depth of anaesthesia was effectively monitored using Bispectral Index (BIS) and Entropy, which are commonly used indices for assessing the depth of anaesthesia. These monitoring techniques are especially important in paediatric patients, as the effects of anaesthetic agents can vary significantly by age. Both BIS and Entropy measure the anaesthetic effect differently for children under one year compared to older children.[20,21] This is critical for ensuring that the anaesthetic depth is adequate throughout the procedure while minimizing the risk of adverse effects.

In terms of nerve grafting, fibrin glue or nerve glue was used for securing autografts. This technique is preferred as it provides better results and is least likely to cause significant hemodynamic variation during surgery.[22] The glue helps stabilize the nerve grafts without requiring additional sutures, thereby improving the precision of nerve reconnection.

Postoperatively, all patients required adequate depth of anaesthesia to tolerate the endotracheal tube (ETT) in the lateral position, as they were subjected to shoulder spica casts. The extubation process was smooth and uneventful in all patients. Significant arousable sedation was observed in patients who received propofol and dexmedetomidine infusions. These patients demonstrated responsiveness within 30 to 40 minutes postoperatively, which is indicative of the effective sedation provided by these agents.

Overall, the use of propofol and dexmedetomidine in combination, with careful monitoring using BIS and Entropy, ensured that paediatric patients undergoing OBPP reconstructive surgeries had stable anaesthesia, minimizing the risks associated with muscle relaxants and inhalational agents, and promoting smooth postoperative recovery.

5. Conclusion

The anaesthetic management of paediatric patients undergoing brachial plexus repair surgeries requires a highly individualized approach, tailored to the specific procedure and the patient's unique needs. This case series highlights the safety and effectiveness of Total Intravenous Anaesthesia (TIVA), particularly with the use of propofol and dexmedetomidine, in paediatric neuro-reconstructive surgeries. These agents provide a stable anaesthetic plane, reduce the need for muscle relaxants, and minimize perioperative complications, making them suitable for complex paediatric surgeries. Moreover, successful management in these cases emphasizes the critical importance of multidisciplinary collaboration, where effective communication between anaesthesiologists, surgeons, and the care team is essential for optimal patient outcomes.

6. Declaration of Patient Consent

Written informed consent was obtained from the patient for publication of this case series and any accompanying images.

7. Source of Funding

None.

8. Conflict of Interest

None.

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Cite this article: Somayaji S, Yaqub M, Shahnaz SS, Dharmlingam M, Chandrika YR. Anaesthetic challenges in paediatric reconstructive surgery for obstetric brachial plexus palsy: A retrospective case series. *Indian J Clin Anaesth*. 2025;12(4):720–725.