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Anaesthetic Management of Scoliosis Correction.

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ABSTRACT

A 5 year old female child admitted with history of inability to walk for the past 6 months and deformity of back since birth. Baby was investigated and diagnosed as congenital kyphoscoliosis with D5 hemi vertebra. She was posted for scoliosis corrective surgery. Important anaesthetic implications in scoliosis surgery are management of massive surgical blood loss, Physiological effects of different positioning of the patient, need for intra operative wake up test to assess the motor function, somato sensory evoked potential monitoring, pain relief & proper planning regarding postoperative ventilation strategies.

Keywords: scoliosis, wake up test, evoked potentials .

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INTRODUCTION

Scoliosis [2] is a complicated spinal deformity involving lateral curvature of spine more than 10 degree vertebral body rotation and angulation of ribs leading to thoracic rib cage deformity. Causes may be congenital, idiopathic or neuromuscular. Adolescent idiopathic scoliosis [2] is common affecting 1 to 3% of children between the ages of 10 to 16 years. Surgical intervention is usually needed if Cobb's angle [4] more than 40 degrees and if there is strong likelihood of curve progression. The main aim of surgery is to prevent the cardio pulmonary deterioration.

CASE REPORT

A 5 year old female child was admitted in orthopaedic ward with history of inability to walk for the past 6 months and deformity of back since birth. Birth history and personal history revealed Full Term and Normal delivery, No history of delayed milestones, properly immunised. History of recurrent respiratory infection present. Baby conscious, oriented, not dyspnoeic, PR-110/min, BP-100/70mmHg, Respiratory Rate-22/min. CVS-S1S2 heard no murmur. RS- Bilateral air entry present, no added sounds. Abdomen-clinical findings normal. CNS- motor system- power in both upper limbs 5/5, lower limbs 3/5. Sensory system intact. Bladder and bowel control normal. Musculoskeletal system-kyphoscoliosis, chest deformity of dorsal spine present. Airway couldn't be assessed because the child was not cooperative.

INVESTIGATIONS

Hb-11gm%, Blood sugar- 90 mg/dl, Urea-26mg/dl, Creatinine-0.9mg/dl, Serum Na- 134meq+, K- 3.8meq+, Blood Grouping and Typing-O+VE, Platelet 1.9lakh/cu.mm, INR-1.06

Chest X Ray PA View: Dorsal kyphoscoliosis with convexity towards right side. Trachea deviated to right side. Measured Cobb's angle was 60°.

ECG-Sinus Tachycardia, otherwise normal

ECHO-normal cardiac chambers and valves, no PHT

USG Abdomen-Normal Study

CT spine- Extreme Kyphoscoliosis with convexity to right. C2-C3 block vertebral body, multiple level coronal cleft and butterfly vertebra from D1-D12 level seen. PFT could not be done because the child was uncooperative.

Preoperative Optimization and Preparation

Respiratory infection was treated with appropriate antibiotics, bronchodilators & chest physiotherapy. Breathing exercise and incentive spirometry could not be performed but baby was encouraged for frequent balloon inflation exercise from one week prior to surgery.

High risk informed consent was obtained, adequate blood products were reserved, difficult airway cart with (different sizes of oral airway, straight and curved laryngoscopic blades, LMA size of 1, 1.5 & 2, intubating bougie, ET tube with size of 5, 5.5, 6) were kept ready since difficult airway was expected in patients with scoliosis. Preoperative fasting guidelines followed. Syp. Ranitidine 5ml (15mg/5ml), Syp. Ondansetron (2mg/5ml) 2.5ml and Syp. Trichlofos 5ml (500mg/5ml) were given 3 hours prior to surgery as premedication.

Intraoperative Management

Operation theatre temperature was maintained around 26 to 28 degree Celsius, the baby was shifted to OT table. Multipara Monitors- NIBP, ECG, and SPO2, ETCO2 were connected. Baby was induced with Oxygen and Sevoflurane 8% with Fresh Gas Flow of six litres per minute with the child in spontaneous ventilation Through Modified Jackson Rees F circuit. IV line secured on right dorsum of hand with 20 G cannula. Inj. Atropine 0.2 mg and inj. Fentanyl 20 micrograms was given and trial laryngoscopy was done after 5 minutes.

with the child is on spontaneous ventilation. Cormack & Lehane grade I was found. Baby was paralysed with inj.Atracurium 5mg and intubated with 5.5 uncuffed ET tube.

After intubation temperature probe placed into nasopharynx, precordial stethoscope fixed near 4th and 5th intercostal space at midclavicular line. Urinary bladder was catheterised. Proper padding was done over the bony prominences, eyes, genital areas and ears.

SSEP, MEP, electromyogram was done. Wake up test not done because of pre-existing neurological deficit and difficult to perform in smaller age group. Intraoperatively anaesthesia was maintained O₂:N₂O= 50%:50% with fresh gas flow of 5 litres/minute and sevoflurane 2%.inj.Fentanyl 10 micrograms was repeated once intraoperatively. Inj.Paracetamol 200 mg IV infusion given during intraoperative period. Inj.Trenexamic acid 200mg given over 10 mins before skin incision to reduce blood loss. Duration of surgery was around 2.5 hours. Fluid management – according to Holliday Segar formula 200 ml of warm RL was given during first 60-90 minutes. During the second hour of the surgery, about 80-100ml of blood loss was noted, which was replaced with packed cells. Urine output was around 75ml.

MAP (Mean Arterial Pressure) was maintained around 60 to 65 mmHg throughout the intraoperative period using Sevoflurane of 2-3%. Inj. Methylprednisolone 250 mg IV was given to prevent spinal cord edema. At the end of the surgery, baby was reversed with inj. Neostigmine 0.5mg and inj.Atropine 0.2 mg and extubated after attaining adequate neuromuscular recovery, when the baby was fully awake. Baby was shifted to PACU. Oxygen supplementation was given through face mask. Morphine 1-2 mg was given intravenously as rescue analgesic and inj.Paracetamol 150mg iv was given 8th hourly for pain relief. Postoperatively motor power was assessed and there was no change compared with the preoperative assessment.

DISCUSSION

Scoliosis has many effects on cardio respiratory system. A restrictive pattern of lung disease results in scoliosis with reduction in chest volume. Reduced lung compliance and restrictive pattern are inversely related to Cobb's angle. Angles more than 60-65^o are associated with significant respiratory manifestations Reduction in vital capacity less than 40% predicts need for post operative ventilation. Total lung capacity, functional residual capacity, inspiratory capacity, and expiratory reserve volume all are decreased. Unless there is coexisting obstructive airway disease the ratio of FEV₁/FVC is normal. Small tidal volume and tachypnoea reduce the work of breathing but increase the dead space ventilation and alveolar hypoventilation. Hypoxemia results because of ventilation perfusions abnormalities. Reduced oxygen tension with a normal carbon dioxide is common but as the disease progresses, ventilation perfusion abnormalities worsen with increased ventilation requirements and eventual respiratory failure. Hypoxia, hypercapnoea, pulmonary vasoconstriction results in pulmonary vascular changes and pulmonary hypertension. If marked scoliosis is present before 8 years of age, alveolar development will be arrested.

Scoliosis is associated with increased incidence of certain congenital heart diseases like MVP, coarctation of aorta due to collagen disorder. Presence of CHD with MVP necessitates infective endocarditis prophylaxis. Restrictive cardiomyopathy with effusion may be there.ECG shows RVH, 'p' pulmonale, RV strain pattern, and dysrrhythmias.RVH and MVP are better diagnosed by echocardiography. PFT could not be performed in this small child. Echocardiogram was done to rule out congenital heart diseases. Breathing exercises like balloon blowing was started one week before surgery to reduce postoperative pulmonary complications. Sedative premedications was not given to this patient to avoid respiratory depression.

Inhalational induction was done without muscle relaxants for intubating this patient, in view of anticipated difficult airway.

Concerns in Prone Position

Patient positioning for surgery varies depending on level of spine and proposed surgery. Anterior thoracic spinal fusion may need lateral position & one lung ventilation which requires double lumen tube. Peripheral nerves, eyes, ears, genitals, bony points should be padded and protected from pressure injury. Lumbar spine surgery may require laparotomy. Intraoperative imaging (using C-arm) is often required. So

surgical site should be away from central support of table. Prone position requires uncompressed abdomen, otherwise it will promote surgical site bleeding through engorged epidural venous plexus.

Large amount of bone exposure above the level of heart predisposes to venous air embolism. Wound must be flushed with saline to reduce air entrapment.

Blood Conservation

In spine surgeries estimated blood loss is around 10 to 30 ml per kg. Following blood conservation strategies are mentioned by various authors. Induced hypotension: moderate induced hypotension with normovolemic haemodilution can bring down transfusion requirement by 50% and shorten operating times. Mean arterial pressure is maintained around 60 -65 mmHg by using volatile anaesthetic agents, Nitroglycerin, Sodium nitroprusside, Trimethapan, Beta blockers. All volatile anaesthetics more than 0.75-1% MAC can produce dose dependant depression of SSEPs.

Antifibrinolytic agents: Aprotinin (polypeptide with serine protease inhibitor activity) and Aminocaproic acid(synthetic analogues) ,Trenexamic acid (inhibitor of plasminogen) have been tried with some success

Preoperative autologous blood donation: This is initiated about 4 weeks preoperatively, allowing 4-7 days between donations; 4 units or more can be collected , depending on need and patient's haemoglobin status. Erythropoietin are given to improve patient haemoglobin.

Acute Normovolemic Haemodilution: crystalloids can be infused before incision with a targeted haematocrit of 25-28% and then removing blood aseptically and storing it in anticoagulated drugs. This reduces blood viscosity and promote organ perfusion .intravascular volume is maintained by replacing the blood with three times the volume a balanced solution, or equal volume of colloid. Intraoperatively ,the previously withdrawn blood is replaced as needed.

Intra operative blood salvage: 50-60% of the red blood cells lost can recovered, concentrated, washed, and returned to patient using commercially available autotransfusion devices.

In our case we have followed hypotensive anaesthesia using volatile agents and also administered antifibrinolytic agent namely Trenexamic acid.

Post Operative Ventilation

The need for elective post operative ventilation depends on the preoperative status of patients (clinical and investigatory findings). Cobb's angle more than 650 are associated significant respiratory manifestations .In scoliosis associated with neuromuscular disorders even lesser degree of Cobb's angle also needs postop ventilation due to severe respiratory impairment.

Reduction in vital capacity to less than 40% predicts need for post operative mechanical ventilation. Incentive spirometry, coughing and deep breathing should be encouraged to reduce risk of postoperative atelectasis and pneumonia

Extubation

At the end of surgery, most of the posterior spinal fusion patients with acceptable vital capacity and adolescent idiopathic scoliosis with mild to moderate pulmonary function abnormalities can be extubated safely. However, if the patient meets out the following criteria, safe extubation can be done

Parameters for extubation are

Vital capacity ≥ 10 ml /kg

Tidal volume ≥ 3 ml/kg

Respiratory rate ≤ 30 /min

Inspiratory force ≥ -30 cm of water.

In our case baby was extubated in fully awake state (as pediatric age group patients are more prone for bronchospasm) after satisfying the extubation parameters

Pain Relief

Narcotic infusion may be continued but should be used judiciously with goal of providing adequate analgesia without excessive respiratory depression For narcotic tolerant patients , subanaesthetic doses 0.2mg/kg bolus, then 2 micrograms/kg/hr of ketamine has been found to be useful after posterior spinal fusions.

Epidural catheters can be placed intra operatively by the surgeon .But it will affect post op neurological examination. Intrapleural infusion of local anaesthetics or opioids For procedure involving extensive spinal levels intra thecal morphine (2-5 mics/kg)administered during surgery has been shown to provide reliable postoperative pain control. Multimodal analgesia allows for effective analgesia with reduced risk of respiratory depression. In our case Inj. paracetamol 8hourly and Inj.Morphine 1mg were given as rescue analgesia Monitor to assess spinal cord integrity Spinal cord may be injured during corrective surgery, mostly because of distraction of cord by instrumentation, disruption of arteriel supply or compression due to haematoma. Risk is more in severe cases (angle \geq 120 degrees, congenital variety, kyphosis with pre-existing neurological deficit. Rate of paraaplegia is around 0.26%

Somatosensory Evoked Potentials (SSEPS)

The posterior column of spinal cord receive sensory information from periphery and then passes to cerebral cortex. a continual assessment of this pathway is SSEP. Repeated electrical stimuli are applied to a peripheral nerve such as posterior tibial nerve or median nerve at wrist evoked potentials over the cerebral cortex and subcortical regions are analysed using standard scalp electrodes. SSEP are good predictors of normal postoperative sensory function. the dorsal column pathways (proprioception and vibration) perfused by posterior spinal artery leaving the motor pathway supplied by anterior spinal artery unmonitored.

An increase in latency (10-15% or more), a decrease in the amplitude (50%), or a complete loss of evoked potential is considered indicative of surgical injury or ischemia until proved otherwise SSEP may be affected by hypoxia , hypercarbia, hypotension, and hypothermia nitrous oxide produce a decrease in amplitude without increase in latency. Among IV anaesthetics narcotics have least effect on SSEP. Muscle relaxants have no effect on SSEP. There was no change in amplitude and latency during the intra operative period.

Motor Evoked Potentials (MEPS)

Integrity of anterior pathway is tested by electrical stimulation of motor cortex using scalp electrodes, or by stimulation of anterior column using epidural electrodes, conduction of these stimuli is monitored through peripheral nerve impulses, actual limb movements. As with SSEP, MEPs are very sensitive to N2O and potent inhalational agents. Thiopentone and Benzodiazepines affect MEP, while Ketamine may enhance MEPs. Muscle relaxants will affect intensity of MEP. Adverse effects of MEP monitoring include cognitive deficits, seizures, bite injuries, intra operative awareness, scalp burns and arrhythmia. MEP monitoring should be avoided in patients with active seizures, vascular clips in the brain, and cochlear implants. Wake up test –its role and complications The wake up test first described by vauzelle(1973), is used to assess integrity of motor pathways and is performed by bringing the patients to lighter plane of anaesthesia, sufficient to allow the patient follow commands. This test is performed once instrumentation is in place or monitoring indicates abnormality. Patients are informed of this step preoperatively and reassured that only minimal pain will felt and they move their hands and feet, anaesthesia will be deepened

Surgeon should notify atleast 30 mins in advance, so that bolus doses of narcotics, relaxants are avoided. during this period, volatile anaesthetic is discontinued, allowing for gradual awakening. Narcotic infusion may be continued till 5minutes before wake up.N2O is withdrawn and patient ventilated by hand, ideally no reversal of muscle relaxants is performed, leaving patient partially paralysed but able to make limited but detectable movement of hands and feet. The patient is first instructed to squeeze the anaesthesiologist hand, confirming that he is responsive, and then asked to move his feet and toes .Patient

usually respond within 5 minutes. If hand movement is elicited but not feet, N₂O is restarted and distraction on rod is released one notch, and test repeated. If still no response is obtained, other causes for paraplegia must be considered. Pain, accidental extubation, myocardial ischemia, self-injury, dislodgement of instrumentation, removal of iv lines, bucking on the tube are some complications. In our case intraoperative neurological assessment was not done due to small age, pre-existing neurological deficit.

Role of Intra Arterial BP Monitoring and ABG Analysis

Invasive BP monitoring is usually indicated when there is possibilities of massive blood loss, need for induced hypotension using drugs such as Inj. Sodium Nitroprusside, Inj. Nitroglycerin infusion and prolonged duration of surgery. Invasive arterial line also permits serial ABG measurements when there is need, and measurements of haemoglobin, haematocrits and serum lactate levels.

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