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ANAESTHETIC MANAGEMENT OF PAEDIATRIC PATIENTS UNDERGOING SCOLIOSIS SURGERY IN CAMP

Dr. Asmita Chaudhary Associate Professor ,Dr. Ankita Patel ,Assistant Professor, Dr. Pooja Patel ,Dr. Hiral Solanki ,Dr. Dhara Kakadiya

Anaesthesia department ;GCS Medical college, Hospital and Research Centre

Oppo. DRM Office, Near chamunda bridge , Naroda road, Ahmedabad , PIN -380025

Abstract

Background

Scoliosis is most commonly idiopathic in origin, but it may be congenital or secondary to neuromuscular disease, trauma, infection or neoplasm.

Aim:

Aims of surgery is to correct the curvature, improve posture and reduce progression of respiratory dysfunction.

Objectives:

Perioperative challenges for anaesthetist in scoliotic surgery are to avoid hypothermia, hemodynamic stability, spinal cord monitoring, positioning, induced hypotension, major blood loss, postoperative pain management and intensive care management of patient.

Material and method:

After taking parenteral consent, 15 paediatric patient's data were collected who underwent scoliotic correction surgery over 12 days from 1st to 12th January of 2019.

Result:

Children underwent posterior fusion scoliosis surgery aged (11.2 ± 2.3) years. surgical duration and blood loss were (7.5 ±1.5) hours, (856 ±235) ml respectively. patients were shifted to ICU because of prolonged procedure and major fluid shift.

Conclusion:

Cardio-respiratory dysfunction may exist as a result of progressive scoliosis or related to coexisting disease, therefore careful preoperative assessment is required.

Intraoperative considerations include the prone position, avoiding hypothermia, minimizing blood loss and monitoring spinal cord function.

Good postoperative pain control is essential and requires a multimodal approach.

Key points: Anaesthesia, Scoliosis, Spinal cord monitoring, Posterior fusion

Introduction

Scoliosis is a lateral curvature and rotation of the thoraco-lumbar vertebrae with a resulting rib cage deformity.

Scoliosis is classified as idiopathic, neuromuscular, congenital, traumatic syndromic, neoplastic and infection[1].

Severity of scoliosis can be measured by cobb's angle. As the scoliosis severity worsens, the cobb's angle increases. If cobb's angle is, <10° No symptoms, >25° Increase in pulmonary artery pressure, >40° Consider surgical intervention, >70° Significant decrease in lung volume, >100° Dyspnoea on exertion, >120°Alveolar hypoventilation, chronic respiratory failure.[2]

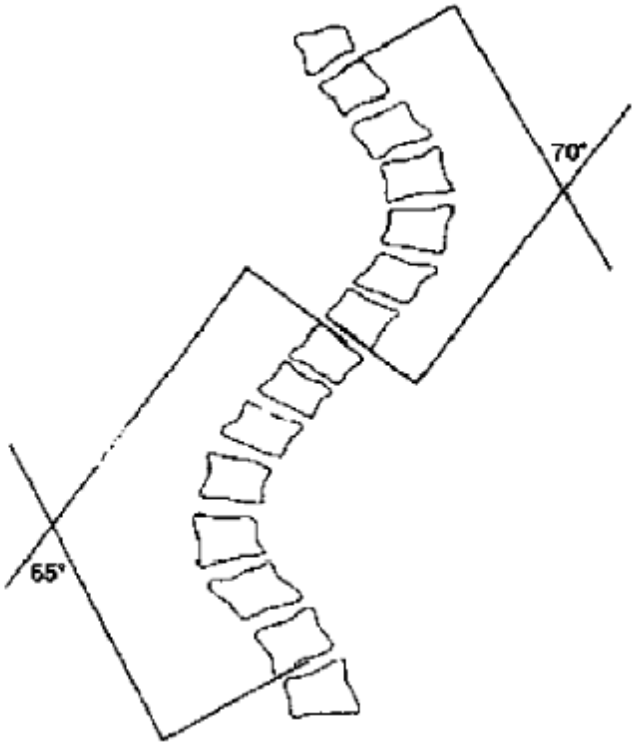

Figure 1: Cobb's method: measurement of severity [3]

Scoliosis results in reduced vital capacity, reduced functional residual capacity (FRC), and restrictive pulmonary disease pattern characterized by increased respiratory rate and decreased tidal volume. As the disease progresses gas exchange is affected by ventilation-perfusion mismatch, alveolar hypoventilation, an increased dead space and an increased alveolar- arterial gradient. Prolonged periods of hypoxemia result in pulmonary hypertension, hypercapnia and eventual respiratory failure. Scoliosis may limit the function of the respiratory muscles like, intercostal muscles may be unable to stretch due to intercostal space changes, putting at a mechanical disadvantage. Moreover, the effectiveness of the muscles may be hampered by limiting the ability of the thorax to expand. The distortion of the thoracic cage makes the respiratory system much less compliant, thus increasing the work of breathing even when the lungs themselves are

healthy. The severity of pulmonary impairment is influenced when cobbs angle (>70°), number of vertebrae involved (7 or more) and cephalad location of the curvature.

The cardiovascular changes associated with scoliosis are less common but more serious than the changes in the respiratory system and share a common aetiology. The alteration in the cardiovascular system is related primarily to the changes in the structure of the mediastinum and secondarily to the effects of chronic respiratory insufficiency.

Patients should be evaluated for presence of congenital heart disease.[3]

We have done detailed neurologic evaluation and documentation. Moreover, patients who have pre-existing neurologic deficits are at an increased risk of developing spinal cord injury during scoliosis surgery.

Neurological injuries during scoliosis surgery are due to direct surgical trauma to the neural elements; compression and/or distraction of the vertebral column; compressive spinal or epidural hematoma and hypotension. Hence, intraoperative neuromuscular monitoring is important to avoid above mentioned complications[4.]

Goals of anaesthesia includes appropriate position, maintain normothermia, minimize blood loss, prevent spinal cord injury and postoperative analgesia.

Method and material

After taking parenteral consent data of 15 patients were collected who underwent scoliosis deformity correction surgery over 12days from 1st to 12th January of 2019.

scoliosis surgery requires extensive preoperative preparation.

Following preoperative investigations were done for scoliosis surgery:

Routine investigations: Blood Tests-Full blood count, coagulation screen, liver function test, urea and electrolytes, calcium and phosphate, blood cross-match, plain chest X-ray, ECG,

arterial blood gases—if spirometry not possible and pulmonary function tests—FEV_1 and FVC.

Additional investigations: Echocardiography, Arterial blood gases—if spirometry not possible.

Pre anaesthetic assessment

Airway assessment:

Difficult airway may be anticipated in case where thoracic or cervical spine scoliosis and devices like halo traction is given.

Respiratory system:

Preoperatively respiratory function was assessed by a thorough history, focusing on functional impairment and effort tolerance, physical examination and appropriate investigations.

Respiratory function was optimized by treating any reversible cause of pulmonary dysfunction by physiotherapy and bronchodilator therapy as indicated. Preoperative incentive spirometry was advised before thoracotomy for anterior approach corrections[4].

Cardiovascular system:

Patients were evaluated for presence of congenital heart diseases.

Neurologic system: A detailed neurologic evaluation and documentation was done because of medicolegal issues.

Psychological preparation:

The use of invasive monitoring lines and catheters along with postoperative analgesia plan was explained fully to the patient and family.

We have taken high-risk consent of all patients in view major surgery.

We ensured **blood products** available in the OT before induction.

Intraoperative period:

Induction and maintenance:

Once IV access was obtained and applied baseline monitors ECG, NIBP, SPO2, patients were induced with inj. Propofol (2 -3 mg/kg), inj. Fentanyl (2-3 mcg/kg) and inj. Ketamine(0.5mg/kg) along with Mask induction with O2 and Sevoflurane. Initiate total intravenous anaesthesia following intubation, and discontinued volatile anaesthetics. We didn't use muscle relaxants as it may interfere with neuromonitoring.

Lines/monitors – We obtained 2 large bore peripheral IV lines and an arterial line. insertion of bite block, orogastric tube, oesophageal temperature probe and urinary catheter were done.

Antibiotics -Cefazoline 25 mg/kg prior to incision and every 3 hourly thereafter was given.

All patients were managed under total intravenous anaesthesia with Inj. Propofol (75-200mcg/kg/min), inj. Fentanyl (2-3mcg/kg/hr) and inj. Ketamine (0.25 -1 mg/kg/hr). Once distraction and instrumentation were over, we reduced infusion rate.

Baseline SSEP, MEPs, EMG were obtained prior to flipping and after 10 minutes of induction.

Intraoperative wake up test has remained the 'gold standard' for assessment of the motor function. during the wake-up test, patients are awakened to the point that they can follow commands to move their feet and squeeze the anaesthetist's hand, the anaesthesia then deepen to allow completion of the surgery. There is a risk of intraoperative recall and accidental extubation. So, we didn't used wake up test.

Out of 15, 2 patients evoked potential were lost. so, after discussion with surgeon and neuro monitoring technician**,** surgery was stopped for a while. we gave 100 % O_2. Hypotension was treated by crystalloids, vasoconstrictor (phenylephrine) and blood transfusion. High dose of steroid (inj. methylprednisolone bolus 30 mg /kg over 15 minutes, followed by 5.4 mg/kg/hr) was given. our target was to maintain MAP ≥ 75 mmhg.

Vulnerable pressure points in prone position include eye, ulnar nerve, nipples, anterior superior iliac spines, and male genitalia were padded properly. Arm were abducted <90°. Proper padding of eyes and lubrication were done to make sure there should be no excessive neck flexion. Proper bolsters were kept at shoulder and hip joint to ensure abdomen was hanging free which facilitates ventilation and improves venous return.

Intraoperative blood loss was reduced by ensuring proper positioning (keep abdomen free in prone position), Antifibrinolytic agents (Tranexamic acid – bolus 10 mg/kg over 10 minutes, then 5 mg/kg/hr) and hypotensive anaesthesia (MAP –60-65 mmhg)**.**

At the end of surgery ,13 patients were extubated. There were 2 patients with severe restrictive lung disease and cobb's angle > 90°. Postoperative analgesia was maintained with Fentanyl infusion,1 gm Paracetamol 8 hourly and Ketorolac 10-15 mg 8 hourly in all patients.

Results

We have managed 15 cases of surgery in our hospital. among these 70 % were male and 30 % were females with age ranging from 8 to 14 years. mean weight of patients was 27.2 kg.

Table 1: Demographic data

Parameters	Mean
Age (years)	(11.2 ± 2.3)

Sex(M/F) %	70:30
weight (kg)	(27.2 ± 4.48)
Cobb's angle (degrees)	(92.57 ± 34.2)

Table 2: Intraoperative parameters

Parameters	Mean
Total consumption of Fentanyl(µg)	(380±30)
Total consumption of Propofol(ml)	(250±20)
Duration of anaesthesia(hours)	(7.5 ±1.5)
Duration of surgery(hours)	(6.2 ± 1.8)
Blood loss(ml)	(856 ±235)
Blood transfused(ml)	(747 ± 169)

Severity of scoliosis assessed by PFT and cobb's angle (mean - 92.57°).

Surgical duration, blood loss and blood transfused were (7.5 ±1.5) hours, (856 ±235) ml and (747 ± 169) respectively.

All patients were managed under TIVA. Average consumption of inj. Fentanyl and inj. Propofol were 380±30 (µg) and 250±20 (ml) respectively.

Intraoperative arrythmias and profound hypotension were observed in one patient which was managed by inj. Amiodarone, inj. Phenylephrine and PCV. There was no obvious complication in rest of patients.

Discussion

Scoliosis which may be of varied aetiology, like: idiopathic, neuromuscular, congenital, traumatic, neoplastic and infectious in origin.

Scoliosis leads to respiratory involvement characterized by restrictive lung disease, ventilation perfusion mismatch that causes hypoxemia. Chronic hypoxemia leads to pulmonary hypertension and eventually progress to right heart failure.

Weinstein et al[5] concluded that the patients with adolescent idiopathic scoliosis who have cobb's angles in thoracic spine measured <30° will have minimal disease progression in adulthood. Surgery is generally indicated in patients whose curvature measured above 40°.

In our study, all patient had cobb's angle more than 90°.

There are various challenges for anaesthesiologist in management of scoliosis corrective surgery like prolonged surgery, prone positioning, major blood loss, hypothermia and neuromonitoring.

After taking parenteral consent, data of 15 patients were collected who underwent scoliosis surgery.

Scoliosis is elective major surgery hence; preoperative optimization is very important for better outcome. All patients were having restrictive lung disease and they were optimized preoperatively by nebulisation, deep breathing exercise, incentive spirometry and chest physiotherapy.

Once IV access was obtained and applied baseline monitors ECG, NIBP, SPO2, patients were induced with inj. Propofol (2 -3 mg/kg), inj. Fentanyl (2-3 mcg/kg) and inj. Ketamine(0.5mg/kg) along with Mask induction with O2 and Sevoflurane. Initiate total intravenous anaesthesia following intubation, and discontinued volatile anaesthetics. We didn't use muscle relaxants as it may interfere with neuromonitoring. Lines/ invasive monitors were attached and antibiotic was given. All patients were maintained under total intravenous anaesthesia with Inj. Propofol (75-200mcg/kg/min), inj. Fentanyl (2-3mcg/kg/hr) and inj. Ketamine (0.25 -1 mg/kg/hr) infusions throughout surgery.

Baseline SSEP, MEPs, EMG were obtained prior to flipping and after 10 minutes of induction. Continuous neuromonitoring were done throughout surgery.

Vulnerable pressure points in prone position include eye, ulnar nerve, nipples, anterior superior iliac spines, and male genitalia were padded properly. Bolsters were placed under chest and pelvis to keep abdomen free.

posterior fixation was done in all patients. After proper exposure, incision was made, paraspinal dissection of vertebrae done to visualize facet joints. Facet joint preserved while fixation with pedicle screw. In one patient, there was severe scoliosis and extensive dissection was needed during fixation of vertebrae. As this patient undergone very extensive instrumentation and costo-transverse resection caused injury to lungs. Bilateral chest tube was inserted. Patient was shifted to ICU. Post-operative CT scan showed pulmonary hemorrhage. Patient died after 7 days.

In extensive spine surgeries blood losses are typically 10 to 30 ml/kg. It is desirable to keep allogenic blood transfusion to a minimum considering the risks of allogenic transfusion i.e., hypothermia, impaired coagulation, hyperkalaemia, hypocalcaemia, transfusion reactions, acute lung injury, transmitted infections etc. This is accomplished by techniques to reduce blood loss and by autologous blood transfusion[3].

We maintained temperature normal by using intraoperative warm blankets.

In our study, mean blood loss was (856 ±235) ml so We transfused 2 packed cell volume to 9 out of 15 patients and 2 FFP to 4 out of 15 patients to maintain the hemodynamic stability and replace the lost volume. Intraoperative blood loss was reduced by ensuring proper positioning, Antifibrinolytic agents (Tranexamic acid – bolus 10 mg/kg over 10 minutes, then 5 mg/kg/hr) and hypotensive anaesthesia (MAP –60-65 mmhg).

Chhabra, et al[6] observed that the duration of the procedure, blood loss, and perioperative complications were significantly more with the posterior fusion (PF) and instrumentation surgery. This is because the surgical procedure is extensive and It involves distraction, decorticating laminae, destroying facet joints and spinous processes of 10-14 vertebrae forming the scoliotic curve to facilitate spine fusion.

Neilipovitz et al[7], showed use of lower dose regimen of tranexamic acid 10 mg/kg followed by an infusion of 1 mg/kg/hour. This regimen having significantly reduce the total amount of blood transfused in perioperative period by 28%.

We did not use cell saver as concern with coagulopathy.

Weiss[8] concluded that the use of Cell Saver does not reduce the need for other transfusions in scoliosis surgery. The amount of blood loss at which Cell Saver is likely to be returned is 500 cc.

The currently available methods to monitor the integrity of spinal cord include ankle clonus test, the wake-up test, Somatosensory evoked potentials (SSEP) and Motor Evoked Potentials (MEP).

SSEP are the most widely used modality for monitoring. It assesses only the integrity of ascending sensory tracts of the dorsal column. SSEPs waveforms are measured in the amplitude and latency. During surgery, electrical impulses are delivered to the median nerve and posterior tibial nerves via surface electrodes. these impulses are then propagated centrally via peripheral nerves to the dorsal column of spinal cord where it ascends the dorsal column to the medulla. In medulla, it crosses the midline and reach to contralateral thalamus and then travels to the primary sensory cortex.When spinal cord function is impaired, there is increase in latency and decrease in amplitude.

MEP monitors the descending motor system located in the anterior and lateral corticospinal tracts that can be elicited by electrical or magnetic transcranial stimulation**.**

When both used combined SSEP and MEP, it improves the sensitivity and predictive value of monitoring.

- Anaesthetic agents and physiologic perturbations may interfere with SSEP and MEP signals.
- Anaesthetic Effects on SSEPs

Volatile anaesthetics produce a dose-dependent increase in latency and decrease in amplitude. Up to 0.5-1 MAC of a volatile anaesthetic in the presence of nitrous oxide is compatible with adequate monitoring of SSEPs. However, there is a high degree of inter-individual variability of response, and the overall quality of the SSEP is superior in the absence of volatile anaesthetics and N_2O.

Intravenous agents have minimal effects on cortical SSEPs, except Etomidate and Ketamine, which actually increase SSEP signal amplitude. Continuous infusion of Propofol 100-200 mcg/kg/min is well-tolerated. Muscle relaxants improve SSEP recording because they suppress EMG activity and provide a “cleaner” background, however NMB will of course obliterate MEPs. High doses of continuously infused opioids are compatible with SSEP monitoring, but bolus doses of opioids and other sedatives should be avoided during critical stages of surgery to eliminate transient effects on the SSEP that may be confused with spinal cord compromise.

- Anaesthetic Effects on MEPs

a) MEPs are extremely sensitive to the inhibitory effects of volatile anaesthetics. Doses as low as 0.25-0.5 MAC can suppress synaptic transmission. Nitrous oxide(N_2O), although less

suppressive than other inhaled agents, demonstrates a synergistic effect on amplitude depression when combined with other anaesthetics.

b) During the spinal fusion, a physiologic and pharmacologic steady state should be maintained as best as possible to effectively use SSEPs and MEPs as monitors of spinal cord function. Any intraoperative neurophysiologic changes (increased latency, decreased amplitude, or complete loss of waveform) should be immediately reported to the anaesthesiologist and surgeon. The team (anaesthesiologist, surgeon and neurophysiologist) should then decide how to address the changes[9,10,11].

Out of 15, 2 patients evoked potential were lost. so, after discussion with surgeon and neuro monitoring technician**,** surgery was stopped for a while. we gave 100 % O_2. Hypotension was treated by crystalloids, vasoconstrictor (phenylephrine) and blood transfusion. High dose of steroid (inj. methylprednisolone bolus 30 mg /kg over 15 minutes, followed by 5.4 mg/kg/hr) was given. our target was to maintain MAP ≥ 75 mmhg.

Hyuns et al[12] concluded that the combined intraoperative SEP monitoring used in conjunction with MEP measurement are very beneficial for preventing intraoperative spinal cord injury. Detection of MEP changes and adjustment of surgical strategy may prevent irreversible pyramidal tract damage.

Schwartz et al[13] concluded that transcranial motor evoked potential monitoring was seen to be extremely sensitive to alteration in spinal cord blood flow as a result of vascular insult or hypotension. Changes in transcranial electric motor evoked potentials are detected earlier than are changes in somatosensory evoked potentials, thereby facilitating more rapid identification of impending spinal cord injury.

Jahangiri et al[14] showed about the importance of both SSEP and MEP in pedical screw placement leading to loss of MEP without any changes of SSEP. That may help to early injury prevention and early intervention due to the higher sensitivity of MEP monitoring.

Combination of SSEP and MEP was used in our set up by a special neuromonitoring team. We did not use the other risky techniques like WAKE-UP TEST. The Wake-up test was about the first who introduced the concept of monitoring the surgical procedure by waking the patient during the surgery to determine the functional integrity of the spinal cord. However, the limitation of such procedure is well known and particularly such a test provides information regarding the motor function only[15].

At the end of surgery ,13 patients were extubated after meeting the extubation criteria and able to move lower limbs. There were 2 patients who had severe restrictive lung disease and cobb's angle > 90°. Those patients were not extubated and kept on ventilator.

Good postoperative analgesia is essential to allow frequent physiotherapy and early mobilization, and so reduce the risk of respiratory complications. Postoperative pain management requires a multimodal approach, combining simple analgesics, systemic opioids and regional anaesthesia. An epidural catheter, or a paravertebral catheter during an anterior correction, can be placed intraoperatively by the surgeon. After initial neurological assessment, a loading dose of local anaesthetic is then given followed by a continuous infusion. However, because of the size of the wound and the surgical disruption of the epidural space, additional analgesia is needed[1].Intraoperative inj. Paracetamol and inj. Fentanyl were given. Postoperative analgesia was maintained with Fentanyl infusion,1 gm Paracetamol 8 hourly and Ketorolac 10-15 mg 8 hourly in all patients.

All other surgeries were completed successfully and uneventful.

Conclusion

Patient undergoing surgical correction of scoliosis present many challenges to anaesthesiologist like maintain normothermia, hemodynamic stability, spinal cord monitoring, positioning, major blood loss and intensive care management requires multimodal approach.

A detailed pre anaesthetic assessment and optimization of respiratory system and cardiovascular system are essential to avoid perioperative complications.

Neurological morbidity has been reduced by continuous neuro monitoring technique. Combined intraoperative SSEP and MEP monitoring are very beneficial for preventing spinal cord injury.

Good postoperative analgesia is essential to allow frequent physiotherapy and early mobilization, and so reduce the risk of respiratory complications.

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