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Intra-Operative Efficacy of General Anaesthesia vs General Anaesthesia with Paediatric Epidural Anaesthesia: A Clinical Comparative Study

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Abstract

Background: Paediatric epidural anaesthesia (PEA) is very safe and effective and in combination withGeneral anaesthesia (GA) offers the advantages of reduced GA drugs, stable haemodynamics and excellent analgesia extended into the post-operative period. *Aims*: To evaluate the efficacy of GA+PEA in comparison to GA with regard to (i) Haemodynamic parameters (ii) dose requirement of Neuromuscular Blocking Agents (NMB) (iii) Quality of surgical relaxation. *Material and Methods*: 80 children of ASA statusI & II (2 to 12 yrs), scheduled for elective surgeries were randomly assigned to GA or GA+PEA groups. Both the groups received routine GA. In GA+PEA, an epidural catheter was inserted and Bupivacaine 0.25% was administered intra-operatively. Haemodynamic parameters, doses of NMB and quality of surgical relaxation (graded by surgeon) were recorded. *Statistical Analysis*: Chi-square test, student-t test and repeated measures ANOVA test were used to analyse categorical, demographic and haemodynamic parameters respectively. A p-value<0.05 was considered significant. *Results*: Rise in heart rate(HR) and mean arterial pressure (MAP) from base-line was significantly lower in GA+PEA with p value of 0.017 and <0.001 respectively. Doses of NMB agents required in GA+PEA were significantly lower with p value <0.001. The grading of quality of surgical relaxation was same in both the groups. *Conclusion*: GA+PEA is more favourable for patients with regard to stable haemodynamics, reduced requirement of NMB agents with equally good surgical relaxation when compared to GA alone.

Keywords: Paediatric Epidural Anaesthesia; General Anaesthesia; Intraoperative; Haemodynamic Parameters; Muscle Relaxant Doses; Surgical Muscle Relaxation.

Introduction

Paediatric central neuraxial blocks have a history dating back to a century. It was Rouston and Stringer of Canada who described lumbar epidural anaesthesia for inguinal hernia repair in infant and children [1].

Precise placement of epidural needles and catheters for single – shot and continuous epidural anaesthesia ensures that the dermatomes involved in the surgical procedure are selectively blocked with the resultant lower doses of local anaesthetics [2,3]. Paediatric Epidural anaesthesia and analgesia provides minimal haemodynamic alterations, excellent relief from surgical pain, subsequent improvement in autonomic, hormonal, metabolic, immunological / inflammatory and neurobehavioural consequences [4].

Paediatric Epidural Anaesthesia (PEA) is very safe and effective especially with advances in ultrasonography and electrostimulation [5]. With individual anaesthesiologist mastering the technique of paediatric epidural anaesthesia, the advantages can be many fold. PEA when combined with General Anaesthesia (GA) offers the advantages of reduced GA drug dosage, stable haemodynamics and excellent analgesia extended into the postoperative period.

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This prospective randomized comparative study compares GA and GA + PEA with regard to haemodynamic parameters, dose requirement of NMB and quality of surgical relaxation.

Methods

After obtaining institutional ethical committee clearance, verbal and written informed consent from all the parents / guardians, 80 consecutive children of ASA physical status I & II, 2 to 12 years of age scheduled to undergo elective surgeries were enrolled in the study. Children were randomly assigned to GA or GA + PEA group. Randomization was generated by Institutional Department of Biostatistics.

All children were pre-medicated with Inj. Midazolam 0.03 mg/kg iv and Inj. Glyco-pyrrolate 0.01 mg/kg iv in the pre-operative holding area. Children were shifted to the operation theatre and monitors like pulse-oximetry, ECG and NIBP were connected. All children were induced with Inj. Propofol 2mg/kg and Inj. Fentanyl 2 µg/kg iv. Relaxation was facilitated with Inj. Vecuronium 0.1mg/kg iv and intubated with appropriate size endotracheal tube (ETT). Anaesthesia was maintained with O_2 + N_2O + Isoflurane + Inj. Vecuronium + Intermittent Positive Pressure Ventilation (IPPV). Intra-operative monitoring included SpO_2, ECG, NIBP, Temperature, End-tidal CO_2 ($EtCO_2$) and urine output (when necessary).

In GA+PEA group, after the induction of anaesthesia, the children were placed in left lateral semi-flexed position. A 19G paediatric epidural kit was used. Under strict aseptic precautions, epidural Tuohy needle was inserted in the appropriate / selected intervertebral space. Epidural space was identified with loss of resistance to saline technique and an epidural catheter was threaded through the needle and the calculated length of the catheter was left in the epidural space. The distal end of catheter was connected to a luer-lock bacterial filter. An epidural test dose of adrenaline 0.4 µg/kg was used in conjunction with negative aspiration to rule out intra vascular placement of catheter. Increase in heart rate >10 bpm within 1 min was considered positive and if so, catheter was reinserted. The epidural catheter was thoroughly secured to the skin using a transparent dressing (without pad).

An epidural injection of 0.25% Bupivacaine (1.5 ml/segment) was injected into the epidural space after negative aspiration for blood and CSF. After positioning the child, surgery was initiated.

In both the groups, parameters like heart rate (HR), mean arterial blood pressure (MAP) were noted at various intervals–baseline (before induction), 5 min, 10 min, 20 min and 30 min duration after induction . Fluids, blood and blood products were transfused as and when necessary. In GA group, Inj. Fentanyl was repeated in a dose of 1 µg/kg iv after every 45 min. In the PEA group, the epidural top-up of 0.25% Bupivacaine 1.5 ml/segment was repeated every 2 hours after the initial dose.

Towards the end of the surgical procedure, children with good respiratory efforts were reversed with Inj. Neostigmine 0.05 mg/kg, Inj. Glycopyrrolate 0.01 mg/kg iv and extubated. Decision of elective ventilation was based on intra-operative events like massive blood loss, hypotension, hypothermia or inadequate respiratory efforts.

The number of muscle relaxant doses were noted. The grading of surgical relaxation was left to the discrimination of the surgeons. They were asked to grade the relaxation as Excellent (E), Good (G), Poor (P) based on their assessment.

Statistical Analysis

Chi-square test was used for categorical data like sex distribution and surgical relaxation. Student t-test was used for demographic parameters like age, weight, duration of surgery and muscle relaxant doses. Haemodynamic parameters like HR and MAP were evaluated using repeated measures ANOVA test. Irrespective of the statistical test used a $p<0.05$ was considered to be of significance.

Results

Eighty children were included in our study. There was no significant difference in demographic parameters like age (Table 1), sex (Table 2), weight (Table 3) and intra-operative parameters like duration of surgery (Table 4).

The HR(Table 6, Graph 1) and MAP(Table 7, Graph 2) in both groups increased from the baseline. The rise in HR and MAP from the baseline was significantly lower in GA+ PEA group at different time points with a p value of 0.017 and <0.001 respectively.

The requirement of muscle relaxant was higher in the GA group, the minimum dose being 4 and maximum dose being 7 (Table 8, Graph 3). In the GA+PEA group, it ranged from 2-5 doses. The mean

± SD was 5.525±0.715 in GA group as compared to 3.075±0.764 in the GA+PEA group. There was a highly significant difference in the maintenance doses of muscle relaxant with a p value <0.001.

In GA group, the grading of surgical relaxation was excellent in 28 children and good in 12 children. In GA+PEA group, the surgical relaxation was graded as excellent in 31 children and good in 9 children(Table 5). A p-value of 0.446 (>0.05) implies that there is no statistically significant difference in intraoperative surgical relaxation between the two groups.

Table 1: Agedistribution(in years)

Group	Min value	Max value	Mean+/-SD
GA	2.6	12	7.49+/-2.80
GA+PEA	2.8	12	6.97+/-2.86

Pvalue 0.409 (>0.05)

Table 2: Sex distribution

Group	Male	Female	Total
GA	15	25	40
GA+PEA	21	19	40
Total	36	44	80

P value 0.178 (>0.05)

Table 3: Weight distribution (inkg)

Group	Min value	Max value	Mean+/-SD
GA	14	40	26.2+/-8.05
GA+PEA	12	35	22.6+/-7.56

P value 0.061 (>0.05)

Table 4 : Duration of surgery (in minutes)

Group	Min value	Max value	Mean+/-SD
GA	90	140	119.8+/-13.6
GA+PEA	60	180	112.8+/-25.9

P value 0.135 (>0.05)

Table 5: Surgical relaxation

Group	Excellent	Satisfactory	Not Satisfactory	Total
GA	28	12	0	40
GA+PEA	31	9	0	40
Total	59	21	0	80

P value 0.446 (>0.05)

Table 6: Heart rate variation

Time Point	Mean (SD) of heart rate in GA	Mean (SD) of heart rate in GA+PEA
Base line	106.6 (18.6)	105.4 (18.2)
5 minutes	121.9 (18.3)	108.9 (17.0)
10 minutes	122.1 (17.4)	109.6 (17.2)
20 minutes	119.8 (25.3)	10.9.1 (17.5)
30 minutes	120.8 (18.7)	108.3 (17.7)

P Value 0.017

Table 7: Mean arterial pressure variation

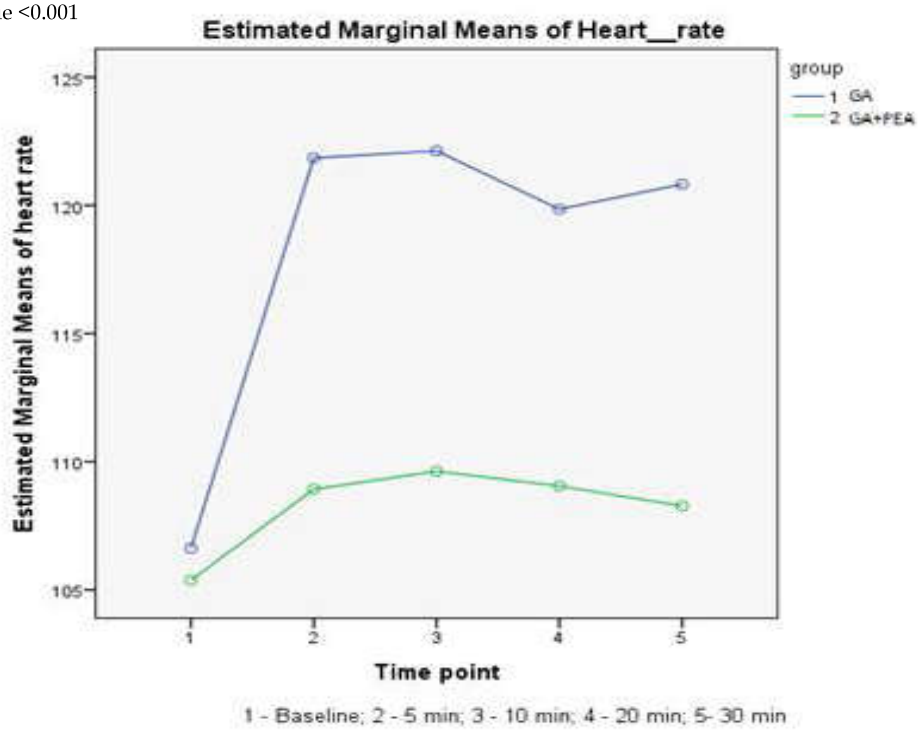
Time point	Mean (SD) of mean arterial pressure in GA	Mean (SD) of mean arterial pressure in GA+PEA
Base line	57.5 (6.4)	58.3 (5.6)
5 minutes	67.4 (7.6)	59.8 (6.2)
10 minutes	67.6 (7.9)	60.0 (6.1)
20 minutes	66.6 (7.1)	59.8 (6.0)
30 minutes	67.0 (7.0)	59.1 (6.3)

P Value <0.001

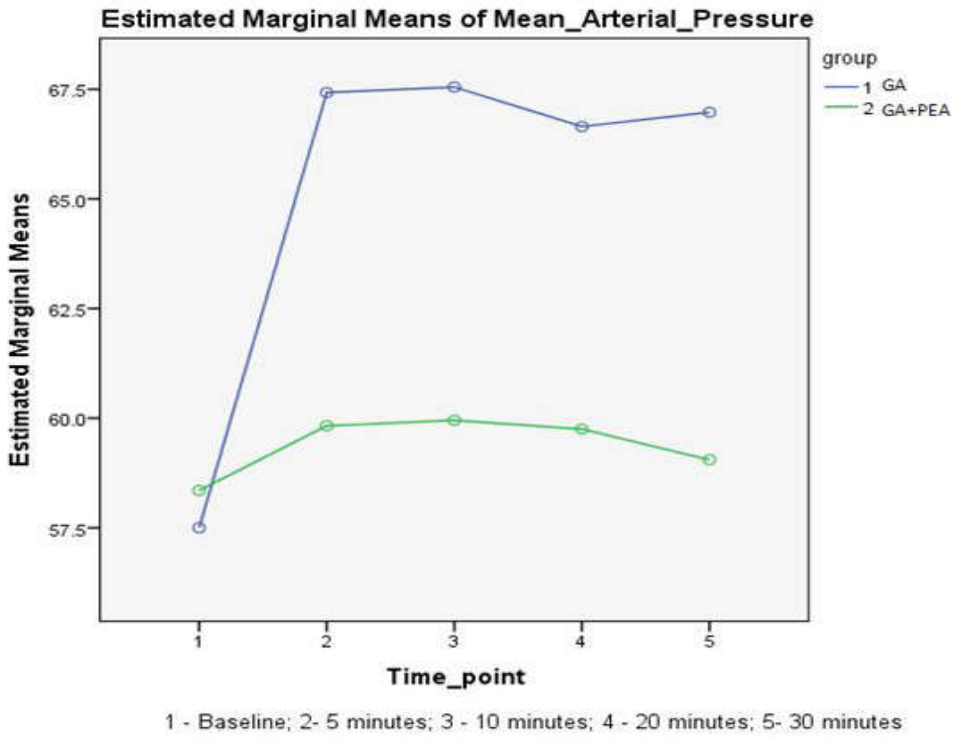
Table 8: NMBdoses

Group	Min value	Max value	Mean+/-SD
GA	4	7	5.525+/-0.715
GA+PEA	2	5	3.075+/-0.764

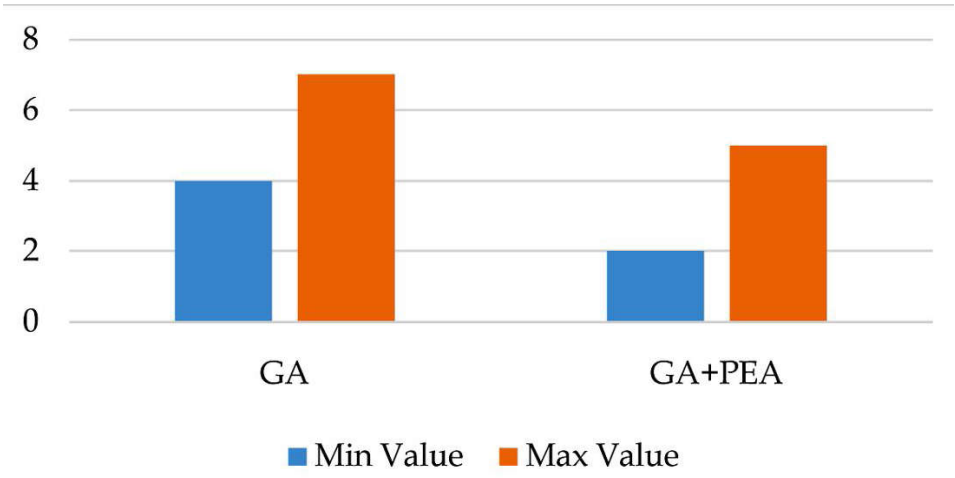
P value <0.001



Graph 2: Mean arterial pressure variation



Graph 1: Heart rate variation



Graph 3: NMB doses

Discussion

This prospective randomized study compares various intra-operative parameters in children undergoing surgery under GA alone or in combination of GA+PEA. The selection of the inter-vertebral space for performance of epidural, epidural test-dose, re-insertion of the catheter if required was done according to the standard recommended guidelines [6,7].

The type of surgeries performed in either of the groups varied from thoracotomy, abdominal, urological and lower limb orthopaedic surgeries. Both the groups had similar pre-medication and induction techniques. The drugs used were calculated on a standard dose/kg body weight chart.

The requirement of muscle relaxant was significantly lesser in GA+PEA group. The administration of NMB in children depends upon a variety of factors namely safety concerns, availability, cost effectiveness, effect on CVS and elimination pathway [8]. When all the above parameters are taken into consideration, a relatively fewer doses of NMB agents are preferable for any type and duration of surgery. This enhances the safety profile in paediatric population.

The statistically significant variation in HR and MAP in the GA+PEA group noted in our study may be attributed to use of isoflurane and propofol. A similar change was observed by A.M.Shabana, A. Shorrab [7]. This minimal haemodynamic alterations may also be due to low resting sympathetic tone and reduced blood in lower extremities in these children [9].

The grading of surgical relaxation was left to the discrimination of the operating surgeon upon completion of the surgery. The grading was done as Excellent, Good or Poor depending upon the surgeon's subjective assessment.There was no significant difference in surgical relaxation between the two groups. This implies that a reduction in the number of doses of muscle relaxant does not affect the quality of surgical relaxation in the PEA group. The epidural drug has a synergistic effect on the action of muscle relaxants. Y. Amaki et al [10] designed a device which could objectively monitor the degree of muscle relaxation. S.J. Bajwa and colleagues [11] in their study considered 4 criteria for surgeon's satisfaction namely – surgical field bleeding, immobility of the patient, degree of muscle relaxation and quality of postoperative analgesia in the ward. Surgeon's satisfaction was graded as Excellent, Good, Fair and Poor in their study. Khan and colleagues [12] evaluated surgical muscle relaxation in 84 paediatric patients by asking the surgeon to grade the degree of muscle relaxation as Good, Fair or Poor.

There are no standard scoring systems for surgical muscle relaxation which is purely a subjective assessment by the operating surgeon, variable from surgeon to surgeon and between surgeon and anaesthetist [13]. Surgical relaxation is monitored clinically by surgeons from tense muscles or by anaesthetists from patients' breathing activity. It can also be monitored using gadgets with facial / thumb muscle twitches or neuromuscular monitoring but these are expensive [12].

Conclusion

In our comparative study of GA and GA+PEA in paediatric population, we conclude that GA+PEA

is more favourable for the patient, anaesthesiologist and surgeon in terms of stable haemodynamics, reduced use of neuromuscular blocking agents and equally favourable surgical relaxation as compared to GA alone. Cost effectiveness with regard to anaesthesia technique, drug usage, etc reduces the burden on health care system in a developing country like India where many health-care schemes are implemented by the government.

Limitation

The cost effectiveness of epidural technique with regard to bed occupancy/hospital stay, ICU expenditure,etc was not evaluated.

Conflict of Interest

There are no conflict of interest with any member of anaesthesia, surgical or administrative team.

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