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SOMATOSENSORY BLOCK IN RELATION TO NON CONVERSION AND CONVERSION OF LUMBAR EPIDURAL ANAESTHESIA TO GENERAL ANAESTHESIA USING PULSE OXIMETER TECHNOLOGY AS MONITORING TOOL FOR LOWER SEGMENT CAESAREAN SECTION SURGERY

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ABSTRACT

Background. Currently lumbar epidural was considered to be the gold standard in anaesthesia practice. Elements involved in epidural anaesthesia procedure were generally individual to the patient’s anatomy, epidural catheter location and response to the medications.

Method. The total number of hundred and sixty (n = 160) parturient undergoing lumbar epidural anaesthesia for lower segment caesarean section LSCS enrolled in this mono centric study. Parturient were in the range of age 16 - 45 years old with ASA I, II and II involved in the study. Visual Analogue Pain Scores VAPS, Bromage scale and perfusion index PI were used as instrument to assess epidural block.

Result. Demographic characteristic did not influence epidural failure. Elements of somatosensory such as Visual Analogue Pain Score, Bromage Scale would be the best assessment of the epidural anaesthesia failure. However, perfusion index could not be used as indicator for assessment of somatosensory block

Conclusion. New heuristics as Transition Policy Anaesthesia Analysis TAPA could be developed for bridging the gaps in determination of failure for epidural anaesthesia especially for caesarean section. Perfusion index PI as displayed by Pulse Oximeter Technology did not have roles for indicating somatosensory block for both non conversion and conversion of epidural anaesthesia to general anaesthesia for Lower Segment Caesarean Section Surgery

Recommendation: Future direction Technologic advances should be using as way to predict epidural failure such as Transcutaneous Electrical Nerve Stimulation (TENS). Ultrasound imaging of the spine could be proposed to facilitate identification of the epidural space and predict difficult spine score, especially in women with abnormal lumbosacral anatomy (scoliosis) and those who were obese. It should be a good level of success in the ultrasound-determined insertion point and very good agreement between ultrasound depth (UD) and needle depth (ND).

KEYWORDS - Pulse Oximetry/Capnograph, Perfusion Value Index SpO2, Epidural Failure, Lower Segment Caesarean Section LSCS, Epidural Anaesthesia/Lumbar Epidural Anaesthesia
INTRODUCTION

Somatosensory block testing was necessary to ensure the degree of blockade sufficient for the LSCS surgery. From our own experiences there were great variations in practice for testing lumbar epidural anaesthesia blockade after administration of local anaesthetic. It was not clearly understood why this happened in clinical anaesthesia practice. We could not even found in any well known textbook how lumbar epidural anaesthesia blocks should be the best option of testing. The method of testing and the metaphor purely depended on the practitioner as well as the type of surgery.

Epidural anaesthesia was a versatile neuraxial anaesthetic technique with an expanding area of indication especially for parturient mothers undergoing LSCS. The use of epidural anaesthesia became so widespread in recent years that many parturient mothers were now requesting repeat epidural anaesthesia for their second or subsequent LSCS. The special focus in this research was to examine hemodynamic changes after epidural administration of local anaesthetics that may provide parameters to predict dermatomal blockade supplemented with Bromage scale. Together with this, pain assessment using Visual Analog Scale (VAS) as a psychometric response scale in the intra-operative period was to be applied. Furthermore, some interest was vested here to check the role Pulse Oximeter during epidural anaesthesia for parturient mothers undergoing LSCS as clinical practice and analysing the arterial haemoglobin saturation (SaO2) with oximetric measurements (SpO2) at the hand. According to Peduto et al (1994) pulse oximetry assessment during epidural anaesthesia gave a falsely low reading when the oximetric sensor was placed at the upper limbs. Currently, pulse oximeter was used for measuring SpO2 reading as during epidural anaesthesia parturient mothers undergoing LSCS experiencing hypothermia and poor perfusion. Therefore it was a good idea to check oxygen saturation (SpO2) in term of Pleth Variability Index (PVI), as a non invasive dynamic indicator for epidural failure among parturient mothers undergoing LSCS.

One valuable consideration LSCS surgery was whether the parturient mothers demonstrated any signs of a response to painful stimuli. If they could not effectively inform about pain, as might occur in the anesthetized state, it became a challenge for the attending anesthesiologist to evaluate the effectiveness of the epidural anaesthesia being used. In any type of anaesthesia, while anaesthesia produced a vasoconstrictive effect, pain was known to induce vasoconstriction, and it was unknown whether a painful stimulus would still maintain vasoconstriction under the vasodilated condition in normothermic, anesthetized parturient. At this junction, the perfusion index PI was an indirect, noninvasive, and continuous measure of peripheral perfusion that provided useful information to the practicing anaesthesiologist in clinical settings. Pulse oximetry provided a relatively simple means to continuously monitor PI in conjunction with other critical parameters, i.e., oxygen saturation and pulse rate in anaesthesia practice. Furthermore, it was expected that the PI provided a means of determining an appropriate monitoring site for pulse oximetry.

Technique of epidural anaesthesia procedure involved injection of drugs through a catheter into the epidural space of the spine, blocking the transmission of pain signals through nerves in the spinal cord. This would cause in temporary loss of pain and sensation below the point of injection. Typically, a 4-inch long needle normally inserted about 2.5 inches deep into the epidural space. The neuromatrix theory of pain explained by Trout (2004) provided a framework that might explain for the relief of pain for the laboring woman. The concept of a pain "neuromatrix" suggested that perception of pain was simultaneously modulated by multiple influences. Another version of pain theory was reference to conversion to general anaesthesia GA occurred intraoperatively.

Le Tagloa et al (2009) did discussed on their survey data for intraoperative conversion of epidural anaesthesia to GA. Le Tagloa et al (2009) admitted that the surveys lacking to specifically assess current anesthetic practices and to determine the impact of these advances (epidural anaesthesia) on caesarean delivery anaesthesia and analgesia. This might be due to poor reliability of tests of block height used in routine clinical practice. Standardized testing of block height with cold, touch, and pinprick were the common practice. There was some concerned about the conversion of epidural anaesthesia for labour to general anaesthesia GA for caesarean section. Unblocked segments or missed Segments (patchy block) occurred more often in parturient than in the general surgical population. The occurrence of residual pain in one area means failure of the total block, since the pain in this area agonizing anaesthesia existed in the neighboring segments.

Actually, majority of parturient mothers could get great benefits from an epidural. Failure of epidural anaesthesia and analgesia noted to occur in our clinical anaesthesia practice. Some technical factors could affect the primary and secondary epidural anaesthesia success rate. Technical problems arose including an appropriate
positioning of the patient, identification of the midline and epidural space, and dislodgement of catheters. In many cases, LSCS surgery was started in the presence of an inadequate block with the reasons for this was not fully understood. The concept of somatosensory block for the intention of decreasing pain perception in epidural anaesthesia was not really available for reference. The context of analgesic need during LSCS surgery by inhibiting somatosensory was not fully discussed in the current literatures. Hypothesis blockade of painful stimuli through epidural anaesthesia before the LSCS surgical stimulus still blurred. Our reviews of the current literature for translating the understanding of somatosensory block as preemptive idea into clinically improvements for parturient satisfaction during LSCS surgery still blind.

MATERIAL AND METHOD

Research Design:

This was a descriptive, cross sectional mono centric study at the Obstetric Theatre. It included anesthetic forms of the Anesthesiology Service referring to charts for parturient of various pre gestational body mass indexes BMI who underwent cesarean section. Variables evaluated included age, weight, height, BMI, physical status (ASA), difficulty in epidural puncture, hemodynamic and anesthetic complications. This study was approved by the Ethics Committee for ethical issues of research. This study was self financed by investigators.

I. SAMPLING AND METHODS::

Parturient mothers planned for elective and emergency LSCS and undergoing epidural anaesthesia chosen as samples of this study. The sampling power was based on Yamane formula n = N / (1 + Ne)² Where n = corrected sample size, N = population size, and e = Margin of error (MoE), e = 0.05 based on the research condition. The total population of parturient undergoing lower segment caesarean section LSCS during the study period was 272 parturient. Hence sample chosen was all together 160 calculated using Yamane formula. Lower Segment Caesarean Section LSCS Surgery would not be begun until loss of sensation to pin prick, ethyl chloride spray and fine cotton wool touch achieved bilaterally to maximum level T7. However, quite a number of cases whereby pinprick, ethyl chloride spray and fine cotton wool touch were not applied. If the block did not reach the level T7 within 30 min or with an additional study drug injected and 45 min after the 3rd dose, the patient would be accepted for this the study as epidural failure. Simultaneously motor block been assessed bilaterally using the modified Bromage scale: 1 = no paralysis (full flexion of hip, knee and foot), 2 = unable to flex hip (able to flex knee and ankle), 3 = unable to flex knee (able to flex foot only), 4 = unable to flex hip, knee or ankle joint. Sampling of the study was done through wide range of age group of all parturient mothers undergoing epidural anaesthesia. The researcher used combination of clinical observational and interventional methods for parturient mothers undergoing for LSCS and examined achievable of satisfactory level of epidural anaesthesia after epidural puncture plus insertion of Tuohy epidural needle and catheter including the injection of drugs used. The Universal Convenience Sampling was used because to have a valid representing of the total populations within the time frame of collecting data.

II. TOOL USED FOR COLLECTING DATA

A check list for LSCS Epidural Anaesthesia was used to collect the data in exploring factors contribute to the satisfactory level of epidural analgesia for parturient mothers planned for elective and emergency LSCS. As clinical practice, a pulse oximeter also been used as continuous monitoring plus as predictor to measure values of SpO₂ for epidural anaesthesia effectiveness. The perfusion index PI was monitored and recorded at five minutes interval for 20 minutes before and after epidural anaesthesia commenced.

III. DATA ANALYSIS

Statistical analyses were performed using SPSS® version 24.0. Frequency or arithmetic mean and standard deviation were calculated for all data. Comparison of categorical variables was made using the chi-square test, Bivariate correlation, Independent T Test and ANOVA were used to evaluate the influence of some variables on successful or failure of epidural anaesthesia with p < 0.05 was considered statistically significant.

RESULTS

Demographic & characteristics of the study subjects

A total of hundred and sixty (160) parturient involved in this study. This was from n = 272 of the total population of parturient undergone epidural anaesthesia during the period of data collection 21st January till 10 of July 2017. The mean age of parturient participated in this study was 28.03 with a standard deviation of ± 5.48. The minimum and maximum ages were 16 and 45 years respectively. Parturient with successful epidural anaesthesia reported to have mean age of 27.96 ± 5.47 where as those with epidural failure that needed conversion to general anaesthesia was 29.83 ± 6.11. for this perspective the age groups were not well distributed as proven in the Figure 1. Age group was tested for normality with Shapiro-Wilk p = 0.00 p < 0.05.
Figure 1: Age groups Distribution
It was very interesting to see the youngest and older age group having high perfusion index PI as compared to the other age groups (Refer Figure 2). There was no significant difference in terms of age group in relation to perfusion index PI as determined by one way ANOVA \( F(6,153 = 9.47), p = 0.50, P > 0.05 \) as revealed by pos hoc Tamhane’s \( T_2 \).

Figure 2: Perfusion Index in Relation to Age Groups
It was noted that mean gravida was 1.84 with minimum and maximum gravida 1 and 7 respectively. At this particular incident, it was observed also that mean parity was 0.86 ± 1.22. On the other hand, successful epidural group had mean parity of 0.76 ± 1.17 and epidural conversion group to general anaesthesia was 1.00 ± 1.10. With this, mean parity was 0.86 ± 1.22. Both elements of para and gravida were not well distributed and again tested for normality with with Shapiro-Wilk \( p = 0.00 \) \( p < 0.05 \). There was no significant difference in terms of gravida and parity in relation to perfusion index PI as determined by one way ANOVA – mean PI by gravida \( F(6,153 = 1.00), p = 0.43 \), mean PI by parity \( F(6,153 = 1.01), p = 0.42 \) as revealed by pos hoc Tamhane’s \( T_2 \).

Figure 3: The trend of distribution for gravida and parity among parturient

If referred to analysis based on ANOVA for conversion and non conversion groups in association with gravida \( r = - 0.06, p = 0.43, p > 0.5 \) and parity \( r = - 0.06, p = 0.47, p > 0.5 \) obviously very clear that parity/gravida did not influence the efficacy of epidural anaesthesia.

Mean pre gestational weight was found 71.29 ± 14.07 kg with minimum of 32 and 104 kg among parturient. For this element, successful epidural group of parturient was 71.03 ± 14.46 and for epidural conversion group was found to be 77.83 ± 9.04 kg. Looking at pre gestational mean height, it was found 1.55 ± 0.08 with minimum of 1.29 and 1.83 meters (m). The mean pre gestational height for successful epidural group was 1.55 ± 0.08 and for the epidural conversion group was 1.56 ± 0.07. The mean pre gestational body mass index BMI among parturient was 29.85 ± 6.09 kg/m\(^2\). With this it was found that the minimum and maximum BMI were 14.81 and 51.68 kg/m\(^2\) respectively. The mean pre gestational BMI for successful epidural group was 29.76 ± 6.11 kg/m\(^2\) and for conversion epidural group 32.30 ± 5.44 kg/m\(^2\). Figure 5 demonstrated the pattern of mean perfusion index PI in relation to body mass index BMI. Based on Pearson’s correlation bivariate analysis it was found \( r = - 0.09, p = 0.27, P > 0.05 \) indicated body mass index did not influenced perfusion index.
The mean epidural needle inserted was 4.45 ± 0.75 cm with minimum of 4.00 and maximum of 10.00 cm. The mean epidural needle insertion for successful group was 4.45 ± 0.76 and for epidural conversion group 4.50 ± 0.45 cm. We analysed the depth of epidural needle insertion between the two groups using Independent T Test (refer Table 1). However there was no significant different when $t(158) = 0.17$, $(p = 0.87, \ p > 0.05)$.

Table 1: Group Statistic in Reference to Epidural Needle Insertion between Non Conversion and Conversion Groups

<table>
<thead>
<tr>
<th>Group Statistics</th>
<th>GA</th>
<th>Conversion</th>
<th>Mea</th>
<th>n</th>
<th>t</th>
<th>df</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catheter Needle</td>
<td>YES</td>
<td>6</td>
<td>4.50</td>
<td>154</td>
<td>4.45</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Inserted</td>
<td>NO</td>
<td>0.1</td>
<td>15</td>
<td>0.6</td>
<td>10</td>
<td>0.05</td>
<td>87</td>
</tr>
</tbody>
</table>

The method of bilateral somatosensory block evaluation two minutes interval applied to for the assessment of effectiveness of epidural anaesthesia. Pin prick was the common technique applied as such for the successful epidural anaesthesia $n = 77$ (48.1%) and for the epidural anaesthesia failure $n = 6$ (3.8%). At this particular issue, seventy five parturient ($n = 75$, 46.9%) was not applied with any technique to assess the effectiveness of epidural anaesthesia. Ethyl Chloride Spray $n = 1$ (0.6%) and fine touch with cotton were not applied for the epidural anaesthesia failure group. Based on Chi Square test we found that the four methods of somatosensory assessment were not equally attractive for best methods as; $\chi^2(3) = 5.78$, $p = 0.12$. In other words there was no significant difference in using the three methods for the somatosensory assessment in epidural anaesthesia.

Pain was evaluated by using a 0 - 10 Visual Analogue Scale VAS (Refer Figure 8). Majority of parturient $n = 136$ (85.0%) in successful group epidural anaesthesia attained Scale 1 for VAS. It was followed by attaining Scale 2 of VAS ($n = 18$, 11.2%) for successful group epidural anaesthesia and nil of parturient attained Scale 3 for this successful epidural anaesthesia group. For epidural anaesthesia failure group, one parturient (0.6%) attained Scale 1, one parturient (0.6%) attained Scale 2 and four parturient (2.6%) attained Scale 3. It was revealed that quite significant that Visual Analogue Scale influence the successful or failure of epidural anaesthesia based on $\chi^2(2) = 106.23$, $p = 0.00$ giving a positive correlation. Thus VAS was a useful tool for the pain assessment in LSCS surgery.
Mean perfusion index PI as indicated by figure 9 below demonstrated that at VAS 1 & VAS 2, the perfusion index was 4.64 and 4.60 respectively. At VAS 3, the perfusion index 4.12 was quite low as compared to VAS 1 and VAS 2. A robust test for equality of means perfusion index PI well distributed as calculated using Waller Duncan for homogeneity. With this phenomenon, it was by ANOVA plot that a good graphic pattern to see perfusion index PI was very realistic when VAS 1 mapped with mean perfusion index PI 4.64. We all believed that as the pain decreased, the perfusion index increased. As such it was revealed in this study that when pain decreased with epidural anaesthesia, perfusion index increased. Unfortunately, Spearman’s coefficient was – 0.03 with p > 0.05, p = 0.69 by non parametric test. Therefore, in this study, VAS did not influenced the reading of perfusion index PI eventhough the pattern shown decreased the VAS value, increasing the perfusion index PI value.

For the left lower limb, number of parturient in successful group of epidural anaesthesia (n = 93, 58.0%) achieved free movement of leg and foot and n = 2 (1.3%) for the failed epidural anaesthesia group. Second criteria that was just able to flex knee with free movement of left foot n = 10 (6.3%) achieved this criteria for the successful group of epidural anaesthesia and n = 2 (1.3%) achieved this criteria for the group of failure epidural anaesthesia. The third criteria of Bromage scale for the right lower limb, it was found n = 4 (2.5%) achieved the level of unable to flex knee but with free movement of foot for the successful group of epidural anaesthesia and n = 1 (0.6%) for the epidural anaesthesia failure group. The fourth criteria of Bromage scale for the right lower limb, the number of parturient in successful group of epidural anaesthesia n = 46 (28.8%) achieved unable to move leg or foot and n = 1 (0.6%) in epidural anaesthesia failure group achieved unable to move leg or foot. We were also not sure why perfusion index (4.61) slightly lowered at the grade III (Unable to flex right knees, with free movement of right feet) with almost 66.0% block. At this particular junction, it was clearly that degree of block did not affect the reading of perfusion index PI. Furthermore, there was no literature discussed this particular area in anaesthesia discipline.
degree of block right limb among parturient demonstrated significant difference. Similarly the p value of 0.03 Bromage score based on four grade criteria degree of block left limb among parturient demonstrated significant difference. Similarly we were also not sure why perfusion index (4.61) slightly lower at the grade III (Unable to flex left knees, but with free movement of left feet) with almost complete 66.0% block compared to Bromage scale grade 1 with characteristic of 0.0% block. For overall perspective, regarding Bromage scale in relation to perfusion index PI unaffected by lower extremities involvement of degree of block. Overall perspective we optimistic that the perfect epidural anaesthesia effectiveness provided a phenomenon of completed pain relief without motor block as based on our own experiences.

With sensory height of T 10 - T 8 with pin prick testing became questionable as at this height still epidural failure occurred. It was among parturient with sensory height between of between T 12 - T 11 and T 7 – T 6 required no conversion to general anaesthesia. The study done by Simiyu (2015) on regional anaesthesia covering the aspect of epidural anaesthesia addressed that conversion rates among patients with sensory height less than T5 was 11 (6.2%). Whereas among parturient with sensory height of between of between T5 and T10 it was 16 (4.4%). While those with sensory height of more than T10 was 4 (12.5%). This finding could not support our result as contrary with finding. There was no statistical significance (Chi-square test p-value = 0.13) in conversion rates among patient’s sensory height. Conversion occurred in patients who had adequate block at first mainly as a result of prolonged surgery. In our setting we did similar opinion with Simiyu (2015) that no statistical significance (Chi-square test p-value = 0.19) in conversion rates among patient’s sensory height. Anova test also revealed that sensory high block (dermatome assessment) did not influenced the reading perfusion index PI as F statistic was 1.03 (df = 2) and p value = 0.36.

What was observed, the mean parturient temperature 36.54° C slightly higher at Dermatome Level of Somatosensory T10 – T8 block achieved for LSCS surgery. It was believed that, signs of successful lumbar epidural anaesthesia block included an increasing in skin/cutaneous temperature plus sympathetic nervous system consequences beside a drop in arterial blood pressure including heaviness of lower extremities. As observed in Figure 12, it was noted that the GA conversion (lumbar epidural anaesthesia failure) occurred among parturient (n = 6) achieved dermatome level of somatosensory block T10 – T8 with mean temperature of 36.54° C which considered slightly hypothermia stage. Element of proceeding to hypothermia stage had been observed during our study of lumbar epidural anaesthesia performed for LSCS surgery.

| Dermatome Level of Somatosensory Block Achieved For LSCS |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| T 12            | - T 10          | T 11            | - T 8           | T 7 - T 6       |
| GA              | YES             | Conversion      | NO              |                 |
|                 |                 |                 |                 |                 |
|                 |                 | 0               | 6               | 0               |
|                 |                 | 7               | 99              | 48              |
| Total           |                 | 7               | 105             | 48              |

**Figure 12: Dermatome Level of Somatosensory Block Achieved For LSCS in Relation to Mean Temperature**

**IV. CONCLUSION**

It was an expectation that low rates of conversion of labour epidural anaesthesia to general anaesthesia GA for caesarean section occurred. While conversion of epidural anaesthesia to general anaesthesia GA implied an inadequate labour anaesthesia and reliable assessment of adequacy of surgical anaesthesia was necessary. It was hoped that perfusion index PI monitoring would warrant further exploration for other clinical anaesthesia applications where information on peripheral perfusion or circulatory status would be useful as predictor for efficacy of epidural...
anaesthesia. The traditional belief of predictor including element of visual analogue scale VAS still existed as main predictor for lumbar epidural anaesthesia failure together with assessment using Bromage scale. Some technical factors also expected to increase the primary and secondary success rate. Perfusion Index could be considered as a technical tool available and had sufficient accuracy and predictability with a growing evidence-base to justify evaluating sympathetic tone or responsiveness in clinical anaesthesia practice. There was a gap at 23.2% for epidural failure when Hermanides et al (2012) described 27.0% for lumbar epidural and our study came out with the small rate of 3.8% among parturient undergoing LSCS surgery. Therefore, perfusion index PI could not be used as indicator for Somatosensory assessment in such as Bromage scale, Visual Analogue Scale and Dermatome level.

V. RECOMMENDATION

Future direction Technologic advances should be used as way to predict epidural failure rather than using common modalities testing including light touch with cotton wool and monofilament and cold sensation. Transcutaneous Electrical Nerve Stimulation (TENS) should be used rather than using pin prick and fine touch with cotton for epidural effectiveness testing. Ultrasound imaging of the spine had recently been proposed to facilitate identification of the epidural space and predict difficult spine score, especially in parturient with abnormal lumbar sacral anatomy (scoliosis) and those who were obese. It should be a good level of success in the ultrasound-determined insertion point and very good agreement between ultrasound depth (UD) and needle depth (ND). There for we would like to propose ultrasound single-screen method, using the transverse approach, could be a reliable guide to facilitate labour epidural insertion. Thus, the epidural failure rate could be minimized in parturient with difficult backbone or spine.

LIMITATION OF THE STUDY

We could not have nerve stimulator something like Transcutaneous Electrical Nerve Stimulation (TENS) and ultrasound guided regional anesthesia techniques in order to reduce migration epidural needle during lower segment caesarean section LSCS surgery. It was supposed to reduce the risk of epidural failure and increase the benefits of this kind of lumbar epidural anaesthesia.

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