THE EFFICACY OF PREEMPTIVE EPIDURAL LEVOBUPIVACAINE AND MORPHINE FOLLOWING THE POSTERIOR FUSION SURGERY IN ADOLESCENTS PATIENTS WITH CONGENITAL SCOLIOSIS

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ABSTRACT

Purpose: Congenital Idiopathic Scoliosis (CIS) is responsible for approximately 70% of all cases of scoliosis. Surgical correction of the CIS associated with severe postoperative pain. The aim of this study is to investigate the effect of the double epidural catheter placed before a posterior instrumentation on postoperative pain management.

Methods: This randomized, prospective, double blind study was approved by the Institutional Review Board. Using a sealed envelope technique patients, who were diagnosed as CIS were allocated one of the two groups. The study groups were as follows; Group I (n=15) “the postoperative intravenous morphine PCA”, Group II (n=15) “preoperative segmental epidural analgesia and postoperative intravenous (IV) PCA”. Standard anaesthesia protocol was applied in all patients. The MEP monitorization and measurements were done after the neuromuscular blockers washout. A standard epidural medication with levobupivacaine and morphine was prepared and administered patients in Group II for every segment to be operated before the surgical intervention. Standard IV morphine PCA was initiated in all patients. Preoperative hemodynamic and postoperative pain data (VAS and VPRS scores), morphine consumption at the first 24 hours and morphine related side effects were noted.

Results: Groups were comparable for demographic data and MEP measurements. Patients in Group I experienced higher postoperative hemodynamic and VAS- VPRS data at rest, movement and stepping. Morphine consumption was higher in Group I compared to Group II (p<0.05).

Conclusion: Initiation of a local anesthetic and opioid combination through double epidural catheter before scoliosis surgery provides improvement in pain levels and decreases IV morphine PCA consumption.

Key words: Analgesia, epidural, Scoliosis, Orthopedic procedures, Pain, postoperative, Adolescents.

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Introduction

Scoliosis is a lateral curvature and rotation of the thoraco-lumbar vertebrae with a resulting rib cage deformity, among the cosmetic deformity, it may lead severe pulmonary and cardiac disorders(1). Even though the Cobb angel higher than 10o is abnormal the abnormalities of 40o and 50o at the lumbar and thoracic vertebra is considered as an indication for surgical correction(1,2).

The aim of surgery is to prevent progression of the curvature of the spine, to maintain posture, and to prevent progression of the pulmonary dysfunction(1). However, the surgical correction procedure for Congenital Idiopathic Scoliosis (CIS) is a challenging one for anaesthesiologists because of the pre-existing disorders, complicated surgical intervention, spinal cord and haemodynamic monitoring, intraoperative positioning, minimisation of blood loss and severe postoperative pain.
Surgical correction of the CIS is associated with severe postoperative pain. Compared to the adults, the children and adolescents are believed to have alleviated pain sensitivity leading higher postoperative pain perception\(^6\). On the other hand the most effective technique for the postoperative pain management is still under debate. Although epidural infusion of opioid and local anesthetic combination, patient controlled intravenous morphine infusion or intermittent non steroidal anti-inflammatory drug or opioid delivery are well described pain management routines, every individual approach has its’ own limitation. Different success rates were reported for postoperative continuous epidural analgesia using opioid and local anesthetic combination via single epidural catheter technique\(^{1,6}\). Alternatively, continuous drug infusion through two epidural catheter technique was described and successfully used for the postoperative pain management considering the fact that single catheter doesn’t comprises the lengthy surgical incision and affected dermatomes\(^7\). Nevertheless, there are concerns about the use of continuous epidural local anesthetics infusion as it may mask the neurological outcome at the early postoperative period and it is considered as a relative contraindication\(^8\).

Pre-emptive analgesia with an epidural catheter and drug infusion is well described as an effective technique which provides decreased anesthetic requirements during the surgical intervention and also reduced postoperative opioid consumptions\(^9\).

In this current study double epidural catheters were placed and a combination of levobupivacaine and morphine was initiated before the start of the surgery. The catheters were withdrawn before the start of the surgery. The aim of this current study is to investigate the effect of the double epidural catheters placed before the surgery on the perioperative parameters and postoperative pain management.

Materials and methods

This randomized, prospective, double blind study was approved by the Institutional Review Board (IRB) and written informed consent of every individual patient or their legal representatives (in case of the patient is younger than 18 years) was obtained. Thirty-three patients who were diagnosed as congenital idiopathic scoliosis and scheduled for posterior instrumentation or fusion were enrolled to the study. Preoperative exclusion criteria were any preoperative neurological or psychiatric disorder, any cardiac disease, any operation due to scoliosis, any bleeding disorder, any previous allergy history to the study medications, drug abuse history and patients refusal to participate the study. The exclusion criteria during the study were technical difficulties in epidural catheterization and accidental dural puncture. Three patients were withdrawn from the study as the epidural catheterization was unsuccessful.

In the preoperative period the study was broadly explained to the patients and their family members or legal representatives and all patients were trained for the use of the Patient Controlled Analgesia (PCA) device (Bodyguard-575, Tar-Mühendislik ve Medikal, Ankara, Turkey) and Visual Analog Scale (VAS; 0: no pain, 10: the worst imaginable pain) rating system. All patients underwent a full neurologic and radiologic evaluation. The Cobb angle was calculated and noted in all patients and the planned surgical procedure (the length of the instrumentation and number of vertebral levels) was discussed with the surgical team.

Using a sealed envelope technique patients were allocated one of the two groups. The study groups were as follows; Group I (n=15) “the postoperative intravenous morphine PCA”, Group II (n=15) “preoperative segmental epidural analgesia and postoperative intravenous morphine PCA”.

Standard American Society of Anaesthesiologist (ASA) monitoring and Bispectral Index Monitoring (BIS) (Aspect Medical Systems, USA) were initiated in all patients and intravenous fluid infusion was started through a peripheral intravenous (IV) line. Intravenous midazolam 0.05 mg/kg was given for sedation to all patients. Anaesthesia induction was done with lidocaine 1 mg/kg and propofol 3 mg/kg. Endotracheal intubation was achieved by rocuronium bromide 0.6 mg/kg. No additional rocuronium was administered after the tracheal intubation. Propofol 60-250 mcg/kg/min and remifentanil 0.05-2 mcg/kg/min were used for anaesthesia maintenance and remifentanil 0.25-1 mcg/kg bolus was given according to haemodynamic changes and BIS values were kept between the values of 40-55 during the study. Pre-emptive IV paracetamol (15 mg/kg) was applied to all patients following anaesthesia induction. In all patients motor evoked potentials were studied and noted. Inhalational anesthetics were not used. Two more IV lines and radial artery
cannula were inserted. Continuous invasive blood pressure monitoring was done in all patients.

Immediately after the anaesthesia induction, the patients in Group II were positioned to lateral decubitus position, and the vertebrae of the patients were supported by pillows for a much straight vertebral column. As the adolescents are more flexible than the adults, this application was performed easily. The centre of the vertebral column that required to be corrected was marked. After the preparation of the skin the epidural catheters were placed at this point, one was directed to cephalad and the other to caudad. The localization of the both catheters was confirmed with given radiopaque solution. A standard epidural medication was prepped by an investigator: 30 mcg/kg morphine was added to levobupivacaine 0.5% 15 ml along with 15 ml of NaCl 0.9%. The total volume of the solution administered was calculated according to the segment that were planned to be operated (2 ml per segment) and withdrawn into a labeled syringe. After the successful epidural catheterization prepped solution was given and the catheters were withdrawn. Three patients were withdrawn from the study due to unsuccessful epidural catheterization. All patients were positioned with close collaboration of the surgical team. Both teams approved final patient position.

Haemodynamic data consisted of blood pressure, heart rate, and SpO2. BIS values were noted basal (after monitorization before anaesthesia induction), after anaesthesia induction and 5th, 10th, 15th, 30th, 45th, 60th, 120th and 180th minutes after anaesthesia induction. Anaesthesia and surgery times were noted. Intraoperative total opioid consumption and total packed red blood cell, fluid amount were also noted.

At the end of the surgical intervention all patients were extubated and transferred to a postoperative care unit. Patients were assessed with Observational Sedation Score (OSS) for postoperative recovery by a blinded observer not involved in the study. OSS 1: patient fully awake, OSS 2: patient is sleepy, OSS 3: patient wakes up with verbal stimuli, OSS 4: patient wakes up with painful stimuli, OSS 5: patient is unarousable. As the patients recovered from anaesthesia (OSS 1 or 2), they were questioned for pain levels and reminded how to use PCA device. Intravenous PCA (0.01-0.03 mg/kg morphine with a maximum of 0.15 mg/kg/hour of bolus and lockout time of 10 minutes) were initiated just after the OSS was at least 2 points (OSS 2). The patients were closely monitored for pain levels at rest, movement and stepping via VAS. The patients were questioned with VPRS (Verbal Rating Scale) scores at rest in same measurement points. When VAS at rest was exceed or equal to 4 point scale, diclofenac sodium was applied to patients via intramuscular. First analgesic requirement time, morphine consumption at the first 24 hours (0th, 1th, 2nd, 4th, 6th, 12th, 24th hours) and morphine related side effects (nausea, vomiting, pruritis, anxiety, insomnia, and urinary retention), were noted by the blinded observer. The quality of sleep and patient satisfaction were assessed with Likerts scale as follows; very bad=1, bad=2, undecided=3, good=4, very good=5.

Patients were transferred to the orthopedics ward at the 24th postoperative hour.

Statistics: An IBM compatible personnel computer was used for statistical analysis. Statistical Program for Social Sciences version 15.0 (Chicago, IL, USA) was used to compute the data. The demographic data were analysed by independent t test and chi square test. The demographic data were presented as mean and standard deviation and numbers and percentage. The continuous data such as haemodynamic data and pain data were analysed with independent and dependent t tests. Data were presented as mean and standard deviation. The chi square test was used to assess the side effects. A p value lower than 0.05 was considered as statistically significant.

Results

A total number of thirty three patients were enrolled into the study. Due to the difficulties in inserting the epidural catheter three patients were withdrawn from the study. The groups were comparable in terms of demographic data. The demographic data were presented in Table 1. Anaesthesia time is slightly longer in Group II due to the insertion of the epidural catheter before the start of the surgery.

Heart rate data were presented in Figure 1. The patients who received epidural catheter prior to the surgery (Group II) demonstrated higher heart rate values compared to Group I starting from the 5th minute measurement till the end of the surgery. However groups were comparable for the postoperative heart rate measurements. The data for mean arterial pressure were presented in Figure 2. Except the 45th minute measurement, the groups were
comparable for blood pressure value during the surgery. However, patients in Group I demonstrated higher blood pressure values compared to Group II on postoperative 12 hours period.

<table>
<thead>
<tr>
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<th>Group I (n=15)</th>
<th>Group II (n=15)</th>
<th>P</th>
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<tbody>
<tr>
<td>Height (cm)</td>
<td>153 ± 14</td>
<td>157 ± 9</td>
<td>NS</td>
</tr>
<tr>
<td>Age (year)</td>
<td>13 ± 3</td>
<td>14 ± 2</td>
<td>NS</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>47 ± 13</td>
<td>49 ± 11</td>
<td>NS</td>
</tr>
<tr>
<td>Gender (F/M)</td>
<td>9/6</td>
<td>12/3</td>
<td>NS</td>
</tr>
<tr>
<td>Surgery Time (minute)</td>
<td>186 ± 13</td>
<td>193 ± 29</td>
<td>NS</td>
</tr>
<tr>
<td>Anesthesia Time (minute)</td>
<td>211 ± 16</td>
<td>231 ± 27</td>
<td>0.01</td>
</tr>
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Table 1: The demographic data of the patients. NS= Statistically not significant, Values are mean and standard deviation. Group I: IV morphine PCA, Group II: preoperative segmental epidural analgesia and postoperative intravenous PCA, + p<0.05: # p<0.05 between groups.

No difference was found among groups on peripheral haemoglobin oxygen saturation and the results were similar between groups. No significant desaturation was observed during the study in groups. The data of total amount of opioid, propofol, blood loss, transfused blood and fluid during surgery were presented in Table 2. Intraoperative total propofol and remifentanil dosage were similar among the groups (p> 0.05). Total blood loss and transfused packed red blood cell and total amount of fluid administered were comparable among groups.

<table>
<thead>
<tr>
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<th>Group I (n=15)</th>
<th>Group I (n=15)</th>
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<tbody>
<tr>
<td>Total propofol (mg)</td>
<td>858 ± 270</td>
<td>930 ± 197</td>
<td>NS</td>
</tr>
<tr>
<td>Total remifentanil (mcg)</td>
<td>1904 ± 666</td>
<td>2105 ± 451</td>
<td>NS</td>
</tr>
<tr>
<td>Total blood loss (mL)</td>
<td>540 ± 433</td>
<td>396 ± 195</td>
<td>NS</td>
</tr>
<tr>
<td>Total transfused RBC (mL)</td>
<td>220 ± 280</td>
<td>66 ± 139</td>
<td>NS</td>
</tr>
<tr>
<td>Total transfused fluid (mL)</td>
<td>2383 ± 705</td>
<td>2223 ± 506</td>
<td>NS</td>
</tr>
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</table>

Table 2: Total amount of opioid, propofol, blood loss, transfused blood and fluid during surgery. NS= Statistically not significant, Values are mean and standard deviation.

Intraoperative BIS values were summarized in Figure 3. No difference was detected between groups on BIS values and all values during anaesthesia were noted on the 40-60 margin.

The postoperative pain data were measured with VAS at rest, at movement, at stepping and pain values with VPRS at rest are presented in Figures 4. Preoperative epidural analgesia in Group II provided significantly better pain scores compared to only IV PCA group at all measurement points. In Group II the total diclofenac sodium (total nonsteroidal anti-inflammatory drug) requirement and total patient controlled opioid consumption was significantly lower than the Group I (Table 3). Moreover the pain scores revealed the fact that the patients in Group II experienced pain levels lower than 4 point scale at all times leading a successful pain management. In eight patients in Group II no additional analgesic was needed and there was a statistical significant difference among groups in terms of patients receiving additional analgesics (p< 0.01). On the other hand, in patients who received addi-
tional analgesics the first analgesic time was significantly earlier in Group I compared to Group II.

The patients were assessed with Observational Sedation score for postoperative recovery and groups were comparable for the postoperative recovery.

Morphine related side effects were reviewed in Table 4. The incidence of itching, nausea, vomiting and hypotension was found to be higher in Group I compared to Group II.

Eleven patients in Group I expressed the “patient satisfaction score” as undecided and only 4 patients rated as “good”. However eleven patients in Group II rated their satisfaction for the postoperative management as excellent (p<0.05 compared to Group I). The remaining four patients in Group II expressed the patient satisfaction score as good.

<table>
<thead>
<tr>
<th></th>
<th>Group I (n=15)</th>
<th>Group II (n=15)</th>
<th>p</th>
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<tbody>
<tr>
<td>Itching (n)</td>
<td>8</td>
<td>0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Urinary retention (n)</td>
<td>0</td>
<td>0</td>
<td>NS</td>
</tr>
<tr>
<td>Nausea (n)</td>
<td>7</td>
<td>1</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Vomiting (n)</td>
<td>6</td>
<td>1</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Hypotension (n)</td>
<td>5</td>
<td>0</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Respiratory depression (n)</td>
<td>0</td>
<td>0</td>
<td>NS</td>
</tr>
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Table 4: Morphine related side effects.
Values are number of patients. Group I: IV morphine PCA, Group II: preoperative segmental epidural analgesia and postoperative intravenous PCA, NS: Not significant.
Discussion

This randomized study reveals that the pre-emptive segmental epidural levobupivacaine-morphine mixture provides higher patient satisfaction and better pain management with minimal side effects compared to conventional IV morphine PCA in patients undergoing posterior instrumentation CIS.

Correctional surgery for CIS is a major and challenging type of surgery for the surgeon and also for the anaesthesiologist requiring a different understanding and techniques. Epidural analgesia stayed out of the option for year due to the possibility of shadowing a neurological deficit result of surgery (10). The other reason disabling the use of epidural catheter was that it was merely impossible to operate with a catheter on.

Continuous epidural analgesia for postoperative pain management in CIS surgery was first described by Shaw (6) and Arms (11). An epidural catheter was placed by the surgeons at the completion of the surgery and it was advanced 6-8 cm to cephalic and tunneled into the paraspinal muscles. Morphine and bupivacaine were initiated through the catheter; however the authors mentioned that single catheter is not enough to cover all dermatomes involved to the surgery as patients experienced high levels of pain (6,11).

Tobias et al (7) used the double catheter technique to cover all affected dermatomes and provide better postoperative pain management. The catheters were advanced to cephalic (from T6-8 to T1-2) and caudally (from T12 to L1-4). Ropivacaine and hydromorphone were the drugs used and the quality of analgesia was described as effective. In this current study a double catheter technique was used, however it was done preoperatively and the catheters were withdrawn immediately, providing better postoperative analgesia and preventing the risk of possible infections. Tobias et al (7) didn’t have a control group as they considered it unethical but this leaded question marks in interpreting the pain results. On the other hand, in this current study a control group who received IV PCA was used to compare the pain management features of preoperative epidural analgesia. The results revealed better pain scores in group where epidural catheters used compared to IV PCA group. Moreover the patients who received epidural medication prior to the surgery expressed far better scores for the patient satisfaction category. Van Boerum et al (5) studied continuous epidural analgesia and compared to IV morphine PCA in similar patient population and found that epidural infusion group had early start in nourishment and discharge from the hospital. Even though, we didn’t focused on the timing of the nourishment and the time of discharge our results showed that the opioid related side effects were less frequent in epidural group. In favoring the results of Van Boerum et al (5) reduced side effects may lead better postoperative outcome and early discharge.

Sucato et al (10) studied retrospective data for the effects continuous epidural analgesia and IV morphine PCA and found two techniques comparable. However epidural analgesia provided more stable analgesia profile and these results are resemble togetherness with our current results. Effective segmental pain control provided by epidural analgesia disabled any fluctuations in pain control.

Pre-emptive analgesia via an epidural catheter provides better analgesia by blocking the painful input to spinal cord and avoiding the central sensitization. Monische et al (12) described the notion of pre-emptive analgesia in their meta-analysis reviewing more than 80 studies. However their results were not favouring the notion truly as negative results were also reported. On the other hand, Ong et al (13), in their Cochrane meta-analysis, expressed that pre-emptive analgesia provides a significant decrease on the postoperative analgesic requirement and reported better results for the pre-emptive analgesia. In this current study the better postoperative analgesia in terms of lower VAS and VPR scores, decreased side effects, longer first analgesic requirement time, better sleep quality, were achieved with preoperative epidural analgesia and supports the notion of pre-emptive analgesia.

Wenk et al (14) reported the success rate of thoracic epidural catheter insertion as 96% in their study focused on the feasibility and efficacy of pre-operative thoracic epidural catheter for postoperative analgesia in anterior scoliosis repair surgery. The results of this study revealed better pain control with VAS scores less than 5.

Motor evoked potential (MEP) study is a crucial monitoring technique, which is considered as a golden standard and a standard patient care for the correctional operation in CIS. Motor evoked potential is used almost in all case in our department in CIS correction surgery. The use of local anesthetics brings the concerns for the accurate MEP study due to a motor block and avoided by many investigators.
and institutes. However we conducted a pilot study
to figure out the offset of the motor block done by
the local anesthetics and return of the normal MEP
after the initiation of the local anesthetics. The data
revealed that the normal MEP results regained after
an approximate time interval of two hours. This
time interval fits perfectly with the time needed for
the patient monitoring, positioning and surgical
exposure. MEP was ready to record before the most
crucial part of the surgery. The authors believe that
the concentration of local anesthetics and opioids
fits perfect for this type surgery where MEP is cru-
ical. Moreover Pham Dang et al(13), compared the
electrophysiological effects of bupivacaine
(0.125%) or ropivacaine (0.2%) added to morphine
in sacral motor neurons. The results revealed that
the impact was very limited and neurological evalu-
ation was not affected. On the other hand Dernedde
et al(10), studied two different levobupivacaine con-
centrations and reported similar results. These
results are in the same route of our results. The
local anesthetics may be suitable adjuncts to opi-
oids for the epidural route with special considera-
tions in CIS correction surgery. The concentration
and type of local anesthetics may play a significant
role in the MEP records, however they provide
effective postoperative analgesia even they were
administered preoperatively. Another concern for
the local anesthetics for not to use in CIS surgery
was that they may mask a neurological deficit after
the surgery. Nevertheless administering the local
anesthetic preoperatively leads a time interval to the
postoperative evaluation and most of the patients
were ready for a neurological evaluation. Moreover
the patients also were not under a risk of a postop-
erative epidural hematoma as the catheters were
immediately withdrawn after the medications were
done.

Opioid related side effects were found to be
much more less in Group II due to decreased con-
sumption of opioids. The major factor for this result
may be the decreased levels of pain levels in Group
II.

There are several shortcomings of this current
study. First of all the dose and the choice of the
local anesthetics may be questioned. Ropivacaine
may be an alternative with decreased motor block
effects. On the other hand different doses of lev-
obupivacaine may also be used. This dose adjust-
ment may lead better MEP records in a more rapid
fashion. The effects of different doses of levobupi-
vacaine or the effectiveness of ropivacaine are
objects of future studies. The second issue of the
study is the timing and technique of the epidural
catheterization. The epidural catheters were placed
before the surgery and it is somehow a troublesome
procedure in patient with scoliosis. The use of ultra-
sound for the future studies may helpful in insertion
of the epidural catheters.

As a conclusion preoperative double epidural
catheter with levobupivacaine and morphine mix-
ture provided effective postoperative analgesia with
higher patient satisfaction and lower opioid related
side effects in patients undergoing correction of
congenital scoliosis.

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