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Comparison of the effects of thoracic and lumbar epidural anaesthesia on induction and maintenance doses of propofol during total i.v. anaesthesia

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Background. In this randomized, double-blind study, the effects of thoracic and lumbar epidural anaesthesia on the induction doses (IDs) and maintenance doses (MDs) of propofol during bispectral index (BIS) guided total i.v. anaesthesia were compared.

Methods. Fifty-four patients (three groups, $n=18$ each) undergoing urological surgery in lumbotomy position were studied in Groups T (Th7–8) and L (L3–4), epidural anaesthesia was performed with initial doses obtaining sensorial block at Th4 (SD 1) followed by 7 ml h^{-1} infusion; Group C received no epidural anaesthesia intraoperatively. The ID (BIS <45) and MD (BIS: 40–50) of propofol and recovery (BIS >80) and extubation times were recorded.

Results. The volume to obtain a block was significantly lower in Group T than in Group L [10.7 (1.5) *vs* 14.7 (1.0) ml; $P<0.001$]. ID was significantly higher in Group C compared with that in Groups T and L [2.16 (0.15) *vs* 1.33 (0.19) *vs* 1.46 (0.14) mg kg^{-1}, respectively; $P<0.001$] with no significant difference between Groups T and L. For MD, there were significant differences between all groups [3.82 (0.9) *vs* 5.8 (1.32) *vs* 9.21 (0.55) mg kg^{-1} h^{-1} in Groups T, L, and C, respectively; $P<0.001$]. For recovery and extubation times, Group T<Group L<Group C [1.4 (0.5) *vs* 3.3 (1.2) *vs* 8.1 (0.99) min, respectively, $P<0.001$; and 3.4 (0.52) *vs* 5.8 (1.32) *vs* 11.4 (1.96) min, respectively; $P<0.0001$].

Conclusions. Similar segments blocked with epidural anaesthesia have resulted in similar ID. During maintenance, identical amounts of bupivacaine applied from different levels have resulted in different MD of propofol. The concentration of the epidural anaesthesia appears to play a more important role than the applied amount of the local anaesthetic.

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Combination of epidural and general anaesthesia is one of the anaesthetic strategies used for major surgery to reduce the requirements of general anaesthetics. Local anaesthetics have been demonstrated to reduce the doses of i.v. and inhalation anaesthetics after the administration via different ways such as epidural,[1–3] intrathecal,[4 5] and i.m.[6–8] However, the exact mechanism of this interaction remains unexplained; moreover, the magnitude of the decrease in general anaesthetic doses is also unknown, which can cause an unwarranted superficial or deep hypnotic component of anaesthesia.

The bispectral index (BIS), an EEG derivative, has been shown to be a reliable and sensitive monitor of the hypnotic component of anaesthesia.[9 10] BIS can be an objective help to determine whether and—if so—how much the doses of hypnotics have to be reduced after the local anaesthetic administration.

The mechanism of the interaction of epidural and general anaesthesia is still not clear, and it has still not been conclusively explained whether the systemic effects of applied local anaesthetic or the epidural anaesthesia are

the crucial factor. We hypothesized that the concentration of the epidural anaesthesia rather than the dose of the local anaesthetic plays a dominant role in the hypnotic effects of the epidural anaesthesia. In a randomized, double-blind study, we tested the effects of thoracic and lumbar epidural anaesthesia on the induction dose (ID) and maintenance dose (MD) of propofol during BIS-guided total i.v. anaesthesia (TIVA).

Methods

With patient informed consent and approval from the local Ethics Committee, we studied 54 ASA I or II patients undergoing urological surgery in lumbotomy position expected to last at least 1 h. To detect a decrease of 0.35 mg kg^{-1} of the ID of propofol (accepting an alpha error of 5% and a beta error of 10%), the required study size was 16 patients per group. Exclusion criteria were general contraindications for epidural anaesthesia, including patients' refusal, known hypersensitivity to the study drugs, preoperative analgesic and hypnotic usage, and any documented preoperative systemic disease, which can interfere with the epidural anaesthesia. Gender, age, weight, and height of the included patients were recorded.

Patients did not receive any premedication. They were prehydrated with 10 ml kg^{-1} of NaCl 0.9% solution, and routine monitoring was applied, including ECG, non-invasive arterial pressure, and pulse oximeter (Horizon 2000, Mennen Medical, Rehovot, Israel). BIS was monitored using a BIS sensor (BIS™ Sensor; Aspect™ Medical Systems, Inc., Newton, MA, USA) applied to the forehead as described by the manufacturer (A-2000 BIS™ monitor, System rev.2.1, Aspect™ Medical Systems, Inc., Norwood, MA, USA). Heart rate (HR), mean arterial pressure (MAP), oxygen saturation (Sp_{O_2}), and BIS were monitored throughout the procedure and the operation. BIS smoothing rate was set at 15 s.

Patients were then randomly allocated to one of three groups according to a sealed envelope technique in a double-blind manner. Before the intervention, all patients were sedated with i.v. midazolam 3 mg. In Group T (thoracic epidural) and Group C (Control) (n=18 each), an 18-gauge epidural catheter (B. Braun, Melsungen, Germany) was inserted through the Th7-8 intervertebral space by a midline approach with the loss-of-resistance technique and placed 3–4 cm in the cephalad direction. In Group L (lumbar epidural) (n=18), the same approach was used to insert an epidural catheter through the L3–4 intervertebral space. In all patients, the placement of the catheter was verified by 3 ml of 2% lidocaine+1/200 000 adrenaline.

Initially, 7 ml of bupivacaine 0.25% in saline+fentanyl 50 μg in Group T and 12 ml of bupivacaine 0.25% in saline+fentanyl 50 μg in Group L were administered to achieve a sensorial block (negative pin-prick) at Th4 at least 30 min before anaesthetic induction.

If the block has not reached Th4 after 15 min, additional doses (1 ml per segment) of a solution consisting of bupivacaine 0.25% plus Fentanyl 5 mg ml^{-1} in saline were administered. If the obtained block was higher than Th3 or lower than Th5 [Th4 (1) level] also after the additional doses, the patient was excluded. An infusion of the same solution (7 ml h^{-1}) was then started in Groups T and L before an induction of general anaesthesia and continued until the end of the operation. In Group C, no loading dose was applied after the test dose; and an epidural infusion of saline (7 ml h^{-1}) was started just before the induction of general anaesthesia and continued until the end of the operation.

After a bolus dose of fentanyl 2 μg kg^{-1} i.v., an anaesthetist, blinded to the applications performed earlier, injected propofol 10 mg (1 ml) in 5 s every 15 s until the BIS score was reduced to <45. The total dose of propofol required to achieve a BIS of <45 was recorded in milligram per kilogram (ID). When BIS value was <45, the response to verbal commands was evaluated. Tracheal intubation was accomplished after administration of rocuronium 0.7 mg kg^{-1}. Volume-controlled ventilation (Dräger SA2, Drägerwerk, Lübeck, Germany) was started with 9 ml kg^{-1} tidal volume and ventilatory frequency was adjusted to maintain endtidal carbon dioxide tension 30–35 mm Hg. Lungs were ventilated with 50% oxygen and 50% air.

After intubation, infusion of propofol 10 mg kg^{-1} h^{-1} was started. The dose of propofol was titrated to keep the BIS score between 40 and 50. When the BIS score was out of these limits for ≥10 s, the dose of propofol was changed by 1 mg kg^{-1} h^{-1} every 20 s. The total MD of propofol during the operation was recorded in milligram per kilogram per hour (MD). Additional doses of rocuronium 0.1 mg kg^{-1} were administered when necessary until skin closure.

Inadequate analgesia was defined as response to surgical stimuli by hypertension (SAP>20% above preoperative baseline value for >5 min) or tachycardia (HR>20% above preoperative baseline value), while BIS level was between 40 and 50. In cases of inadequate analgesia, patients were given additional doses of fentanyl 1 μg kg^{-1}.

Bradycardia was defined as HR<40 beat min^{-1} and hypotension as a decrease in SAP>20% of the baseline value. Hypotension was treated by infusion of lactated Ringer's solution 3–5 ml kg^{-1}, and if necessary, with ephedrine 5 mg i.v. Bradycardia was treated with atropine 0.5 mg i.v. The frequency of hypotension, bradycardia, inadequate analgesia, and supplemental fentanyl doses was recorded.

To assess intraoperative awareness, a number was repetitively recited to each patient four times during anaesthesia at 5, 10, 15, and 20 min. In the postoperative period, the patients were specifically questioned for recall of this number.