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Original Article

Investigation of the Effects of Spinal Dexamethasone Injection as a Premedication in Rabbit Anesthesia

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ABSTRACT

Anesthesia and analgesia are important in human and veterinary medicine, especially in surgical procedures. Rodents, avians, and exotic species are required to be anesthetized using an appropriate anesthetic regimen. This study aimed to suggest a new anesthetic drug and method in order to facilitate anesthesia as well as analgesia among rabbits, laboratory animals, and humans. Spinal injection of dexamethasone combined with intramuscular ketamine among rabbits can play the role of premedication agents. A total of 24 healthy white adult rabbits from New-Zealand were equally assigned into four groups. Groups 1, 2, 3, and 4 were subjected to spinal xylazine (5mg/kg) with ketamine (35mg/kg,IM), spinal dexamethasone (0.37mg/kg-four times diluted) with ketamine (35mg/kg,IM), dexamethasone (4mg/kg,IM) with ketamine (35mg/kg,IM), and spinal dexamethasone (0.37mg/kg-four times diluted), respectively. The results showed that there was a significant difference in terms of clinical reflexes recorded for group 2, compared to groups 1 and 3. A significant difference was also observed regarding clinical reflexes between group 2 and the other groups. Furthermore, no abnormality was observed in terms of histological sections within groups 2 and 4. Spinal dexamethasone can be used as a premedication combined with ketamine in rabbit anesthesia.

Keywords: Anesthesia, Dexamethasone, Premedication, Rabbit, Spine

Étude des effets de l'injection spinale de dexaméthasone en tant que prémédication lors de l'anesthésie chez le lapin

Résumé: L'anesthésie et l'analgésie sont importantes en médecine humaine et vétérinaire, en particulier dans les procédures chirurgicales. Les rongeurs, les oiseaux et les espèces exotiques doivent être anesthésiés à l'aide d'un traitement anesthésique approprié. Cette étude visait à suggérer un nouveau médicament anesthésique et une nouvelle méthode afin de faciliter l'anesthésie ainsi que l'analgésie chez les lapins, les animaux de laboratoire et les humains. L'injection spinale de dexaméthasone associée à de la kétamine par voie intramusculaire chez le lapin peut être ulisée comme prémédication. Au total, 24 lapins blancs adultes de Nouvelle-Zélande, en bonne santé, ont été également répartis dans quatre groupes. Les groupes 1, 2, 3 et 4 ont été soumis à une xylazine spinale (5 mg/kg) avec de la kétamine (35mg/kg, IM), de la dexaméthasone spinale (0.37mg/kg diluée quatre fois) accompagnée de kétamine (35mg/kg,IM), dexaméthasone (4mg/kg,IM) et kétamine (35mg/kg,IM) et la dexaméthasone spinale (0.37mg/kg, diluée quatre fois). Les résultats ont montré qu'il existait une différence significative en termes de réflexes cliniques enregistrés pour le groupe 2 par rapport aux groupes 1 et 3. Une différence significative a également été observée concernant les réflexes cliniques entre le groupe 2 et tous les

autres groupes. De plus, aucune anomalie n'a été observée au niveau des coupes histologiques dans les groupes 2 et 4. La dexaméthasone spinale peut donc être utilisée comme prémédication en association avec de la kétamine lors d'une anesthésie chez le lapin.
Mots-clés: Anesthésie, Dexaméthasone, Prémédication, Lapin, Colonne vertébrale

INTRODUCTION

Anesthesia has always been a controversial issue in human and veterinary medicine. Surgery cannot be performed unless a suitable anesthetic regimen is applied. In veterinary surgery, especially among rodents, avians, and exotic species, anesthesia is important; however, routine anesthetic agents cannot induce ideal anesthesia. This study suggests a new protocol and method in rodent premedication in order to induce an analgesic, muscle relaxant, and sedative effect during surgery. The combination of a suitable premedication with an anesthetic induction agent can lead to ideal anesthesia and operation. Currently, there is no ideal drug or combination of drugs for postoperative spinal analgesia (Armand et al., 1988; Tavakoli and Kazemi-Mehrjerdi, 2011; Marjani et al., 2014). There are several injectable agents to induce analgesia and sedation by spinal and epidural injection in human and veterinary medicine. Non-steroidal anti-inflammatory drugs, corticosteroids, anticholinesterases, inhibitors of nitric oxide synthase, vasopressin, and somatostatin have all been shown to have some degrees of analgesic effect when administered epidurally. Currently, none has been used clinically by epidural injection (Hall et al., 2001). Glucocorticoids (e.g., prednisone, prednisolone, and methylprednisolone) are most commonly administered by systemic routes, either oral or injectable, to relieve pain and reduce inflammation. Perineural injection, either to spinal nerve roots or to peripheral nerves, is common in human patients to alleviate pain caused by nerve root disease or peripheral neuropathies. The beneficial effects of epidurally administered betamethasone in a rat model of lumbar radiculopathy have been reported (Hayashi et al., 1998; Abram, 2000; Tranquili et al., 2007). Due to the introduction of lidocaine as a local anesthetic, it is used as epidural administration in all of the species (Hedenbro and Olsson, 1998; Johnston, 2005; Barros et al., 2007). Xylazine, an alpha-2 agonist drug is used by epidural administration as a premedication to induce a muscle relaxant effect. There are two reasons why the study of anesthesia, analgesia, and sedation is important among rabbits and other laboratory animals. The first one is the practical use of the suggested protocol in veterinary medicine and surgery, especially in orthopedic surgery. Moreover, laboratory species can be used as animal models and the results can be generalized to human cases. Furthermore, in laboratory studies, analgesics are required to fix animal and perform the procedure (Malinovsky et al., 1997; Hedenbro and Olsson, 1998). Available agents, especially corticosteroids, which are anti-inflammatory and antipyretic drugs (Allen, 2007; Stefan et al., 2015), cannot induce the ideal analgesic and sedative effects. The effective analgesic and sedative agents combined with anesthetic induction are required in painful procedures among rabbits and rodents. Dexamethasone is a glucocorticoid injectable drug which is anti-nausea (Henzi et al., 2000), and antiemetic (Ho et al., 2004; Ho et al., 2011) decreasing tissue inflammation and increasing glucose level (Allen, 2007). Dexamethasone is also analgesic and sedative because of elevating dopamine level (Yasukazu et al., 1993) and GABA receptors (Yasukazu et al., 1993; Di et al., 2009) and decreasing serotonin (Allen, 2007). Epidural injection of corticosteroids similar to methylprednisolone acetate and betamethasone did not have any histological changes in the spinal cord (Cicala et al., 1990).

Analgesic effect of local anesthetic was increased by adding dexamethasone to epidural ropivacaine (Kim et al., 2014; Yousef et al., 2014). The combination of intrathecal dexamethasone with bupivacaine improves the duration of sensory block (Bani-Hashem et al., 2011). It is believed that dexamethasone reduces the need for opioids (Jno-Baptiste et al., 2014). Several studies have shown that the intravenously or intrathecally administration of steroids, especially dexamethasone, in various doses, leads to the reduction of pain intensity, morphine/pethidine consumption, and post-operative nausea and vomiting (Bisgaard et al., 2003; Samarkandi et al., 2004; Jno-Baptiste et al., 2014). All of these properties are required to make dexamethasone a premedication agent combined with ketamine.

MATERIAL AND METHODS

Animals. Totally, 24 healthy adult male albino rabbits from New-Zealand weighting 2.5 to 3 kg (mean weight 2.3 ± 0.2 kg) were randomly chosen for this study. The experimental protocol used was reviewed and approved by the Institutional Animal Care and Use Committee, Science and Research Branch, Islamic Azad University, Tehran, Iran.

Rabbits were housed individually in standard cages and all of them had free access to food and water with a natural light-dark cycle. Groups 1, 2, 3, and 4 received 5mg/kg spinal xylazine plus 35 mg/kg intramuscular ketamine, 0.37 mg/kg spinal dexamethasone plus 35mg/kg intramuscular ketamine, 4mg/kg intramuscular dexamethasone plus 35mg/kg intramuscular ketamine, and 0.37mg/kg spinal dexamethasone, respectively.

Experimental design. After the aseptic preparation of dorsal part of the lumbosacral area, a 23 gauge needle was inserted to the area between L7 and S1 and the drugs were injected directly into the spinal cord in groups 1, 2 and 4. In group 1, xylazine (5mg/kg) was injected into the spinal cord from the lumbosacral area and after five minutes, ketamine (35mg/kg, IM) was injected. After general anesthesia, clinical reflexes associated with anesthesia were evaluated and the data were recorded in tables (Tranquili et al., 2007). The rabbits that were assigned into group 2 received 0.37mg/kg four times diluted spinal dexamethasone. After five minutes, 35mg/kg intramuscular ketamine was injected into all six rabbits and the data were recorded. In group 3, all rabbits received 4mg/kg intramuscular dexamethasone plus 35mg/kg intramuscular ketamine. Moreover, all rabbits in group 4, received 0.37mg/kg four times diluted spinal dexamethasone. Heating pads were used during anesthesia and recovery for all rabbits. Evaluated reflexes include reflexes related to cardiovascular, respiratory, gastrointestinal, ocular, musculoskeletal, and nervous systems. All rabbits were monitored a day later and no neurological disorders were observed. On day 21, all rabbits in groups 1, 2 and 4 were euthanized and pathologic sections of the spine, L5 to S3, were prepared.

Statistical analysis. Kruskal-Wallis H and Mann-Whitney U tests were used to measure P-values of reflexes within groups as well as between group 2 and the other groups, respectively.

RESULTS

Clinical reflexes. The mean of the measured variables was compared within and among the groups. The P-value less than 0.05 was considered statistically significant. Out of 22 clinical reflexes compared between group 2 and 1, 15 reflexes were reported to have significant differences statistically ($P<0.05$, table 1). Moreover, significant differences were observed in terms of 18 evaluated reflexes out of 26 ones between group 2 and 3($P<0.05$, table 2).

Histopathology. No abnormalities were observed in terms of the injection site and surrounding areas of the spinal cord in groups 2 and 4. Neurons were checked and included normal nuclei and nucleoli. Additionally, cytoplasm included normal Nissl bodies and Virchow-Robin spaces were normal. Histologic sections of groups 2 and 4 were compared with those of group 1

individually. No differences were observed in this regard (Figures 1 and 2).

Table 1. Comparison of P-value of evaluated reflexes between group 2 and the other groups

	2 and 1	2 and 3	2 and 4
Pulse	0.57	1	0.7
CRT*	0.01	1	0.5
Respiratory rate	0.38	0.03	0.02
Respiratory depth	0.52	0.001	0.01
Respiratory action	0.38	0.06	0.1
Cough reflex	0.47	0.3	0.03
Laryngeal reflex	0.26	0.1	0.1
Intubation possible	0.57	0.09	0.01
Mucous membrane*	0.01	1	1
Salivation*	0.007	0.01	0.3
Oropharyngeal reflex*	0.002	0.001	0.0009
Vomiting	0.13	0.05	0.1
Jaw tone	0.15	0.002	0.001
Limb muscle tone*	0.01	0.002	0.001
Abdominal muscle tone*	0.007	0.002	0.002
Sphincters*	0.007	0.001	0.0009
Pupils	0.056	0.0009	1
Corneal*	0.002	0.001	0.0009
Lacrimal*	0.02	0.001	0.001
Photomotor reflex*	0.006	0.2	0.004
Palpebral reflex*	0.05	0.0009	0.001
Eyeball position	1	1	0.001
Nistagmus*	0.05	1	0.3
Sensorium*	0.01	0.0009	0.0009
Pedal reflex*	0.01	0.001	0.0009
Reaction to surgery*	0.05	0.001	0.0009

DISCUSSION

There are significant differences regarding the majority of the evaluated reflexes between group 2 and those of the other groups. In group 1, spinal xylazine plus intramuscular ketamine were injected as a routine protocol for anesthesia among rabbits. Clinical reflexes within group 2 were significantly different from those of the other three groups followed by no observed squeaking during injections. Furthermore, post mortem examination showed that injections were done in proper sites. In group 3, intramuscular dexamethasone could never play the role of an expected premedication. Group 4 was designed only for comparing pathologic signs and clinical reflexes. The obtained results showed significant differences between this group and group 2 in this regard. Totally, there were significant differences in terms of all reflexes between group 2 and the other groups, except for five reflexes, namely pulse, respiratory action, laryngeal, vomiting, and nystagmus. The results of this study showed that dexamethasone spinal injection has analgesic and sedative effects among rabbits. Therefore, dexamethasone can be used as a premedication. Dexamethasone is a synthetic glucocorticosteroid which is an influential anti-inflammatory drug that is 25-50 times more potent than hydrocortisone and is up to 16 times as effective as prednisolone. Dexamethasone is utilized frequently in the perioperative setting, including prophylaxis against postoperative nausea and vomiting, and the reduction of the airway and cerebral edema. It may also be useful in the management of acute and chronic pain (Allen, 2007). Moreover, it is available and cost-benefit synthetic glucocorticoid. Many researchers conducted studies on the effects of spinal and epidural injection of different synthetic corticosteroids, such as betamethasone, methylprednisolone, and dexamethasone. The results showed the analgesic and anti-inflammatory effects of these corticosteroids. Cicala et al. showed that the combination of epidural methylprednisolone acetate and lidocaine 1% did not lead to the occurrence of any inflammatory changes in meninges and spine (Cicala et al., 1990). Moreover, epidural injection of betamethasone did not result in any changes in clinical reflexes among dogs, while histological changes were observed in the treatment group (Barros et al., 2007). Additionally, dexamethasone-soaked gelatin sponges had a synergistic effect on the prevention of adhesion of epidural space among rabbits. In another similar study carried out on 36 Wistar rats having undergone laminectomy, dexamethasone gelatin sponge could obviously inhibit the inflammatory reaction of operation site as well as scar formation and adhesion (Fang et al., 2015; Tian et al., 2015). In another study, Hong Min et al. showed that 300 µg of epidural dexamethasone had an analgesic effect on peripheral inflammation tissue injury in a rat model (Min et al., 2014). Dexamethasone was also used among human medicine, as an analgesic. Post-operative pain in children undergoing orchiopexy surgery (Kim et al.,

2014) was decreased significantly by adding 0.1 mg/kg dexamethasone to epidural ropivacaine.

Table 2. Evaluation of Mean ± SD related to all reflexes

	1	2	3	4
Pulse	2.5 ± 0.547	2.33 ± 0.516	2.33 ± 0.516	2.16 ± 0.752
CRT	2.5 ± 0.836	1.16 ± 0.408	1.16 ± 0.408	1.33 ± 0.516
Respiratory rate	2.66 ± 1.03	2.33 ± 0.516	1.50 ± 0.547	1.33 ± 0.816
Respiratory depth	2.33 ± 0.516	2.16 ± 0.408	1.00 ± 0.000	1.33 ± 0.516
Respiratory action	1.84 ± 0.752	1.50 ± 0.836	2.33 ± 0.516	2.00 ± 0.000
Cough reflex	1.16 ± 0.752	1.66 ± 1.032	2.16 ± 0.752	0.50 ± 0.547
Laryngeal reflex	1.33 ± 2.06	2.66 ± 2.065	4.00 ± 0.000	4.00 ± 0.000
Intubation possible	1.50 ± 0.547	1.66 ± 0.516	1.16 ± 0.408	1.00 ± 0.000
Mucous membrane	2.33 ± 1.032	1.00 ± 0.000	1.00 ± 0.000	1.00 ± 0.000
Salivation	1.33 ± 1.032	0.00 ± 0.000	0.66 ± 0.516	0.16 ± 0.408
Oropharyngeal reflex	2.66 ± 1.211	0.00 ± 0.000	3.33 ± 0.516	4.00 ± 0.000
Vomiting	0.33 ± 0.516	0.00 ± 0.000	.050 ± 0.547	0.33 ± 0.516
Jaw tone	2.00 ± 0.632	1.33 ± 0.816	3.16 ± 0.408	4.00 ± 0.000
Limb muscle tone	2.00 ± 1.095	0.33 ± 0.516	3.66 ± 0.816	4.00 ± 0.000
Abdominal muscle tone	1.66 ± 0.516	0.33 ± 0.516	3.00 ± 1.095	3.83 ± 0.408
Sphincters	1.16 ± 0.752	0.00 ± 0.000	1.83 ± 0.408	2.00 ± 0.000
Pupils	1.50 ± 0.547	0.00 ± 0.000	3.00 ± 0.000	2.00 ± 0.000
Corneal reflex	2.33 ± 0.516	4.00 ± 0.000	2.66 ± 0.816	1.00 ± 0.000
Lacrimal reflex	2.83 ± 0.983	4.000 ± 0.000	1.33 ± 0.516	0.16 ± 0.408
Photomotor reflex	3.50 ± 0.836	1.50 ± 0.547	2.16 ± 0.983	0.16 ± 0.408
Palpebral reflex	3.50 ± 0.547	4.00 ± 0.000	1.00 ± 0.000	0.16 ± 0.408
Eyeball position	2.00 ± 0.000	2.00 ± 0.000	2.00 ± 0.000	0.16 ± 0.408
Nistagmus	0.50 ± 0.547	0.00 ± 0.000	0.00 ± 0.000	0.16 ± 0.408
Sensorium	0.66 ± 0.516	0.00 ± 0.000	1.00 ± 0.000	3.00 ± 0.000
Pedal reflex	2.00 ± 1.549	0.00 ± 0.000	3.16 ± 0.408	4.00 ± 0.000
Reaction to surgery	0.50 ± 0.547	0.00 ± 0.000	2.50 ± 1.643	4.00 ± 0.000

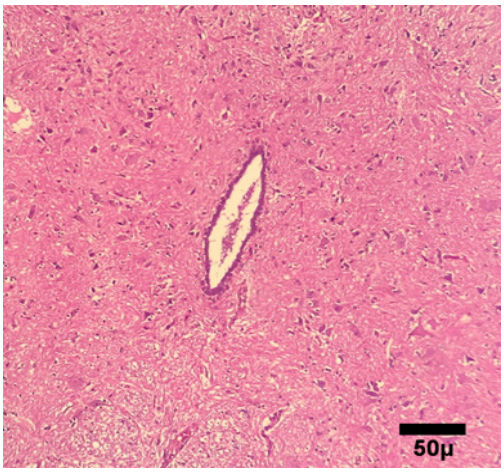

Figure 1. Histological section of spinal cord related to group 2 (H&E×40).

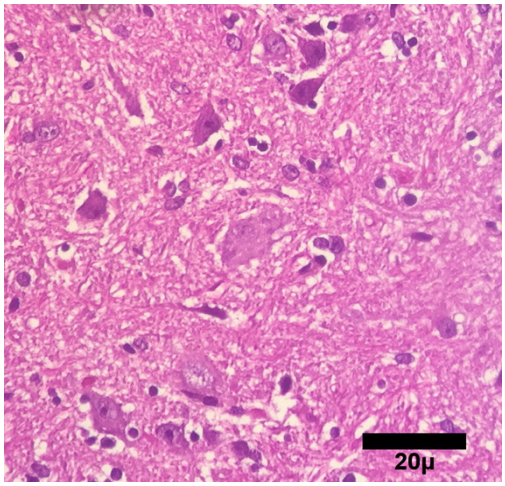

Figure 2. Histological section of spinal cord related to group 2 (H&E×100).

In another similar study, the duration of postoperative analgesia in children undergoing inguinal hernia repair prolonged significantly by adding dexamethasone or magnesium to caudal ropivacaine. Moreover, the time of the first analgesic dose was longer and the need for rescue postoperative analgesia was reduced with no increase in the incidence of side effects (Yousef et al., 2014).The duration of sensory block in spinal anesthesia was improved significantly by adding intrathecal dexamethasone to bupivacaine for spinal anesthesia without any changes in onset time and

complications in orthopedic surgery (Hedenbro and Olsson, 1998). Statistical analysis of clinical reflexes as well as the histological evaluation of spine sections have proved the obvious advantages of dexamethasone spinal injection as a premedication method among rabbits. It was also shown as an analgesic agent in other laboratory animals and human. The anti-inflammatory, analgesic, and sedative effects of corticosteroids, especially dexamethasone, were proved in this study which was in line with the results of other similar studies. In addition, anti-nausea, and anti-emetic effects of dexamethasone can enhance the performance of surgeons regarding the surgical procedures.

According to the obtained results, spinal dexamethasone can be used as an ideal premedication, combined with ketamine among rabbits.

Ethics

We hereby declare all ethical standards have been respected in preparation of the submitted article.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

Abram, S.E., 2000. Neural Blockade for Neuropathic Pain. Clin J Pain 16, 56-61.

Allen, K., 2007. Dexamethasone: An All Purpose Agent. Aust Anaesth 65-70.

Armand, S., Langlade, A., Boutros, A., 1988. Meta-Analysis of the Efficacy of Extradural Clonidine to Relieve Postoperative Pain: An Impossible Task. Br J Aneasth 81, 126-134.

Bani-Hashem, N., Hassan-Nasab, B., Alijan-Pour, E., AmriMaleh, P., Nabavi, A., Jabbari, A., 2011. Addition of Intrathecal Dexamethasone to Bupivacaine for Spinal Anesthesia in Orthopedic Surgery. Saudi J Anaesth 5, 382–386.

Barros, G., Marques, M., Ganem, E., 2007. The Effects of Intrathecal Administration of Betamethasone over the Dogs' Spinal Cord and Meninges. Acta Cir Bras 22, 361-365.

Bisgaard, T., Klarskov, B., Kehlet, H., Rosenburg, J., 2003. Pre operativedexamethasone Improves Surgical Outcome After Laproscopic Cholecystectomy:A Randomized, Double-Blind Placebo-Controlled Trial. Ann Surgery 238, 651-660.

Cicala, R., Turner, Moran, E., Henley, R., Wong, R., Evans, J., 1990. Methylprednisolone acetate does not cause inflammatory changes in the epidural space. Anesthesiology 72, 556-558.

Di, S., Maxson, M., Franco, A., Tasker, J., 2009. Glucocorticoids Regulate Glutamate and GABA Synapse-Specific Retrograde Transmission via Divergent Nongenomic Signaling Pathways. J Neurosci 29, 393-401.

Fang, H., Zhang, M., Yue, G., 2015. Dexamethasone-Soaked Gelatin Sponges Prevent Epidural Adhesion. J Clin Rehabil Tissue Engin Res 8, 1165-1169.

Hall, L., Clarke, K., Trim, C., 2001. General Principles of Local Analgesia. In: Veterinary Anesthesia, WB Saunders Co.

Hayashi, N., Weinstein, J., Meller, S., Lee, H., Spratt, K., Gebhart, G., 1998. The Effect of Epidural Injection of Betamethasone or Bupivacaine in a Rat Model of Lumbar Radiculopathy. Spine 23, 877-885.

Hedenbro, J., Olsson, A., 1998. Metoclopramide and Ureteric Colic. Acta Chir Scand 157, 439-440

Henzi, I., Walder, B., Tramer, M., 2000. Dexamethasone for the Prevention of Postoperative Nausea Dn Vomiting: A Quantitative Systematic Review. Anesth Analg 90, 186-194.

Ho, C., Ho, S., Wang, J., Tsai, S., Chai, C., 2011. Dexamethasone Prevents Postoperative Nausea And Vomiting. Benefit Risk 49, 100-104.

Ho, C., Wu, H., Ho, S., Wang, J., 2004. Dexamethasone Has a Central Antiemetic Mechanism in Decerebrated Cats. Anesth Analg 99, 734–739.

Jno-Baptiste, B., Scarlett, M.D., Harding, H.E., 2014. The Effect of Dexamethasone on Post-Operative Opioid Requirement in Patients Who Underwent Gynecology Surgery at the University Hospital in Jamaica. J Anesth Clin Res 1, 5-11.

Johnston, M., 2005. Clinical Approaches to Analgesia in Ferrets and Rabbits in Proceeding. Seminars In Avian And Exotic Pet Med 14, 229-235.

Kim, E.M., Lee, J.R., Koo, B.N., Im, Y.J., Oh, H.J., J.H.L., 2014. Analgesic Efficacy Of Caudal Dexamethasone Combined With Ropivacaine In Children Undergoing Orchiopexy. Br. J Anaesth. 112, 885-891.

Malinovsky, J.M., Bernard, J.M., Baudrimont, M., 1997. A Chronic Model for Experimental Investigation of Epidural Anaesthesia in the Rabbit. Reganesth and Pain Med. 22, 80-85.

Marjani, M., Tavakoli, A., J.Tavakoli, 2014. Comparison The Analgesic Effects Of Lidocaine, Xylazine And Their Combination Used Into The Epidural Space In Rabbits. I.J.V.S.T. 9, 17-21.

Min, S.H., Soh, J.S., Park, J.Y., Choi, S.U., Lee, H.W., Lee, J.J., *et al.*, 2014. Epidural Dexamethasone Decreased Inflammatory Hyperalgesia And Spinal CPLA2 Expression In A Rat Formalin Test. Yonsei Med J 55, 1631–1639.

Samarkandi, A., Shaikh, M., Ahmad, R., Alammar, A., 2004. Use of Dexamethasone to Reduce Postoperative Vomiting and Pain after Pediatrictonsillectomy Procedures. Saudi Med J 25, 1636-1639.

Stefan, M.T., Spoorenberg, S.M.C., Rijkers, G.T., Grutters, J.C., E.M.W. Van De Garde, Meijvis, S.C.A., *et al.*, 2015. Antipyretic Effect of Dexamethasone in Community-Acquired Pneumonia. Eur Resp J 46, 570-573.

Tavakoli, A., Kazemi-Mehrjerdi, H., 2011. Addition of Metoclopramide or Tramadol on Analgesic Effects of Lidocaine in Epidural Analgesia in Rabbit. I.J.V.S.T. 3, 41-48.

Tian, F., Dou, C., Qi, S., Zhao, L., Chen, B., Yan, H., *et al.*, 2015. Preventive effect of dexamethasone gelatin sponge on the lumbosacral epidural adhesion. Int J Clin Exp Med 8, 5478.

Tranquili, W.J., Thurmon, J.C., Grimm, K.A., 2007. Lumb & Jones' Veterinary Anesthesia and Analgesia Blackwell Publishing.

Yasukazu, K., Masahiko, M., Namiko, N., Kiyohisa, T., 1993. Differential Effect of Subchronic Dexamethasone Treatment on Serotonin-2 And/3-Adrenergic Receptors in the Rat Cerebral Cortex and Hippocampus. Neurosci Lett 155, 195-198.

Yousef, G.T., Ibrahim, T.H., Khder, A., Ibrahim, M., 2014. Enhancement of Ropivacaine Caudal Analgesia Using Dexamethasone or Magnesium in Children Undergoing Inguinal Hernia Repair. Anesth Essays Res 8, 13-19.