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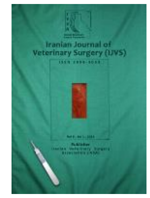

ORIGINAL ARTICLE

Evaluation of Low-Level Laser Effects on Epidural Anesthesia in Horse

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Local anesthesia

Abstract

Objective- To evaluate and compare the analgesic effects of caudal epidural administration of lidocaine (LIDO), caudal laser radiation and epidural lidocaine plus laser radiation in horses.
Study design- A blinded, randomized, prospective, experimental cross-over study.
Animals- Five healthy horses, 15.7 +/- 4.9 years of age, weighing 240 +/- 37 kg.
Methods- The horses were randomly assigned to receive four treatments (group NS: saline (0.9% NaCl) solution via caudal epidural injection, group L: lidocaine (2 mg/kg of body weight) via caudal epidural injection, group LLL: laser radiation (3000Hrtz- for 10 minute) and group LL: caudal epidural lidocaine injection plus laser radiation at intervals of at least 1 week. A 20 gauge 55*0.9 mm needle was placed in the first intercoccygeal space (Co1-Co2) in conscious standing horses restrained in stocks for epidural injections. Two metal sheets were sticked in pocket like bags on position of origin and insertion of semitendinosus muscle in right and left sides for electrical stimulation response and motor and sensory blockade evaluations used by TENS machine. Degree of perineal analgesia was also assessed by pin prick induced with a 20 gauge 55*0.9 mm needle and pinch test evaluated by use of a hemostat clamp. Anal and vaginal tone was also recorded. Positive pain responses were defined as purposeful avoidance movements of the head toward the stimulation site were used to indicate analgesia.

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Results- All epidural injections were made without problems. Analgesia produced in the tail, perineum and upper hind limb in all horses received lidocaine. Statistical analyses assessing sensory and motor stimulation did not show a significant difference between horses in groups 1, 2, 3, 4 in right and left sides.

Conclusion and clinical Relevance- We concluded that low level laser in combination with caudal epidural lidocaine treatments provided sufficient analgesia in horses, and this treatment is offered a longer duration of analgesia than laser, lidocaine caudal administration although the sensory and motor stimulation did not show significant difference between groups. Low level laser may be effective adjuvants in caudal epidural anesthesia in horses. Our results showed that LLL plus lidocaine may be preferable to a high dose of epidural lidocaine.

1. Introduction

In recent years there have been many advances in using spinal techniques to provide anesthesia and analgesia for many surgical and pain relieving procedures in horses. Epidural injection is a common method of producing analgesia and local anaesthesia of the tail and perineal structures in conscious standing horses for doing standing surgeries including ovariectomies, laparascopic cryptorchidectomy, caslik, perineal hernias, cervical tears, rectovaginal tears-etc. Current attitudes about animal welfare have increased the importance of pain management in livestock. Even minor surgical procedures in livestock are now performed using a combination of regional, local, or general anesthesia combined with uninterrupted post-surgical analgesia. Epidural injection of local anesthetics is a convenient method of producing analgesia that have sensory effects without motor nerve paralysis, thus providing pain control without these horses becoming recumbent[1]. Horses experience pain in a similar fashion as human do and show emotional responses, suggesting that there is an effective component to their nociceptive experience.[2] Recently there has been considerable interest, especially in human obstetrics, in using spinal analgesia to provide sensory blocks without interfering with motor control.[4,5,6] Most women experience significant pain during labor and birth, and most women receive some form of pharmacologic pain relief. Epidurals are the most effective method, but there are some risks. Both the effectiveness and side-effects vary depending on the specific drugs and dosages, where and how the drugs are injected, and the timing of both the first and last doses in relation to the progress of the labor. Many different local anesthetics have been used, The anesthetics act primarily by interfering with transmission of neural stimulation through the sympathetic, sensory, and motor nerve fibers that emerge from the spinal cord in the lumbar area.[1,4,5]

The desired analgesic effect results from the action of the drugs on the sensory nerves fibers; the undesirable side effects result from the action of the drugs on the sympathetic and motor nerve fibers. The site of action of local analgesics given epidurally is still controversial but the main sites are thought to be the nerve roots within the dura and nerve tracts in the superficial layers of the spinal cord. Various drugs may act as adjuvants when combined with local anesthetics to prolong the duration and efficiency of caudal epidural analgesia in horses. These drugs include opioid analgesics, ketamine, and a2-adrenergic agonists. Combining narcotics with lower doses of anesthetics makes it possible to reduce the anesthetic concentrations and total doses of drugs, thus providing the same or better analgesia while reducing the degree of motor block. Morphine, like other opioids, is absorbed into the cerebrospinal fluid and is believed to act on receptors in the substantia gelatinosa of the dorsal horn of the spinal cord.[1,2,3] Low-level lasers on surgery site has been advocated to reduce the amount of analgesic drug consumption during surgery and pain after surgery.[7,8]

Low-level lasers are a group of lasers with a power less than 250 mW and unlike high-power lasers they have no effect on tissue temperature; they produce light-dependent chemical reactions in tissues. These lasers have analgesic features with their ability to trigger reactions that reduce pain and inflammatory mediators. Low-level lasers can also be used instead of needles in acupuncture to decrease pain. Due to these features they have been used in the treatment of orofacial pains, including tooth hypersensitivity, post-operative flare-ups, mucositis, facial myalgia, temporomandibular joint disorders and neuralgia.

Low level laser therapy (LLLT) has been considered as an effective, safe and side effects free means that can be replaced or combined with drugs. The analgesic effect of LLLT is another motivating factor for its application after surgery. It increases the analgesic effect of drugs, reduces drug consumption and eliminates drug complications. The most common used analgesic drugs after surgery are opiums and NSAIDs (Non Steroidal Anti Inflammatory Drugs).[1]

According to Mokmeli et al study, LLLT (980nm, dose 4 J/cm², for 3 days) in acute pain control service after vertebral surgery, reduced narcotic consumption dramatically in laser group, 29% of LLL treated patients didn't get narcotic injection and their pain was controlled orally but the entire control group got narcotic injections furthermore, the amount of narcotic consumption (mg/kg) was lower in laser group compared to control group.[7]

These are evidences to suggest that LLL can help to increase analgesic effects of local epidural anesthesia. This study was designed to assess the analgesic efficacy, motor blockade, and sensory effects of caudal epidural lidocaine injection in comparison with combination of lidocaine caudal epidural with low power laser radiation.

2. Materials and Methods

The study and experimental design were approved by the Committee for Animal Experimentation of the Large Animal Hospital, Faculty of Veterinary Medicine Univercity of Tehran. Five healthy horses (one male and four females) weighing 230-290 kg (mean, 406 kg) and aged 4- 12 years (mean, 12 years) were selected. During the experimental period, all animals were maintained in stalls in the Large Animal Hospital, Faculty of Veterinary Medicine University of Tehran. Horses were provided by water and hay ad libitum, each animal underwent four treatments in a crossover study design:

Group NS: saline (0.9% NaCl) solution via caudal epidural injection, group L: lidocaine (2 mg/kg of body weight) via caudal epidural injection, group LLL: laser radiation (3000 hertz- for 10 minutes), and group LL: The interval between the treatments was one week. Before the experiment, the skin area over the first intercoccygeal (CO1-CO2) space, sacrum to the insertion of semitendinosus muscle was shaved and washed. Then the skin was dried and bag like pockets were sticked on the skin in the area of origin and insertion of semitendinosus muscle on the right and left side of the horse. Two electrodes were placed in each bag on the origin and insertion of the semitendinosus muscle on each side. So the electrical stimulation was performed bilaterally to allow the stimulus to reach the dorsal and ventral branches of the both sensory and motor nerves.

Laser type Red type, C 90,Diode-GaAlInp/CE, Wave Length 650, Power 100 mv, Energy 6 Jul/min, Spread 25/0 cm^2, Radiation Density 4/0 vat/cm2, Radiation Dose 100 mJ/sec Angle 15 degree, Through the external neural branches, Radiation type 10 minute, Depth 4cm.

All animals received a standard noxious stimulus consisting of skin and deep muscle pinprick of tail, perineum, and upper hind limb with a 22-G, 2.5-cm-long needle and a pinch with a hemostat clamp (closed to the first ratchet) in the same regions (Fig 2). Lack of analgesia (a strong positive response to a noxious stimulus) was ensured before drug administration. Analgesic, sedation, and motor blockades were evaluated as presented in Table 1 and were assessed before and after each stimulation. Sensory and motor nerve stimulation were assessed with using Trans cutaneous electrical nerve stimulation machine (model) program 4 as sensory and program 53 as motor stimulator. Data recording was performed on 0, 5, 10, 15, 20, 25, 30, 35, 40, and 60 minutes after the treatment.

Table 1. Scoring system for analgesic, sedation, and motor blockade in horses[1]

Scores Definition of Scoring
Analgesic
1 Normal response, with a strong reaction to painful stimulus or kicking
2 Mild analgesia, with no immediate response to skin pinprick but with tail swishing, low whole-body reaction, and turning toward site of painful stimulus
3 Moderate analgesia, with no tail swishing, no response to skin and deep muscle pinprick, without whole-body reaction but restless
4 Complete analgesia, animals calm and indifferent to a painful stimulus Sedation
Sedative
1 No sedative effect, no changes in head position
2 Reduced alertness and slight drop of the head with upper eyelids drooped
3 Mild drowsiness and lowering of the head with nostril to the elbow
Motor blockade
1 Quietly standing, no change in limb position or any other signs
2 No reluctance to move, no tail movements, loss of anal reflex, and vulva and vaginal relaxation in females
3 Presence or absence of ataxia according to a visual analog scale with the animal restrained in a stanchion, and then by walking after treatment
4 Recumbent

TENS-transcutaneous electrical stimulation therapy was executed with a two-electrode machine (model New DYN 640 B,2000 SERIES, Novin Co. Iran). Two stimulating programs were chosen for sensory and motor muscle response. 100 hrtz for motor and 80 hrtz for sensory nerve function were used in 10 seconds and muscle jerk were record in mili Amper unit.

The total duration of the treatment was 30 minute. Then the electerodes were placed to allow the arrival of the stimulus to the caudal nerve terminate from caudal spinal root.

The results were compared for each individual treatment.

Statistical analyses were done by SPSS software version 16.0 The descriptive statistics described (showed) by Mean

± SEM. Analysis were measured with 95% Confidence Interval was carried out by General Linear Model (GLM) procedure for times trends measures. Results were assessed by One-way ANOVA and LSD post Hoc tests. A p value less than 0.05 was considered statistically significant.

3. Results

All epidural injections were made without problems. Analgesia produced in the tail, perineum and upper hind limb in all horses received lidocaine. Ataxia was seen earlier in horses received laser radiation and lidocaine injection than the horses in group 2 with lidocaine analgesia. Laser radiation increased analgesic effects of lidocaine in comparison with epidural lidocaine alone, in group 2. The time of onset of analgesia was just after laser radiation and happened sooner than lidocaine group (10 min after injection). Satisfactory analgesia was obtained when horses did not respond to needle pricks or hemostat pinches. Program 4 (100 HZ)-10 SECONDS for motor and program 53(80 HZ) 10 seconds for sensory neuron stimulation are applied on right and left sides by TENS machine.

Statistical analyses assessing sensory and motor stimulation did not show a significant difference between horses in groups 1, 2, 3, 4 in right and left sides.

Table 2. Mean ± SEM of L4, L53, R4, R53 in different times and groups.

Group	P-L4	P-L53	P-R4	P-R53
1	0.281	0.601	0.891	0.207
2	0.061	0.464	0.221	0.338
3	0.924	0.464	0.711	0.9
4	0.453	0.481	0.251	0.320

Between times 0 to 60 minutes in groups 1to 4 showed significant difference ($p>0.05$) in t25 and t60 of left and t20 of right side motor neuron stimulation. $p>0.05$ was also seen in times 20 and 10 of left side and time 10 of right side sensory neuron stimulation. Motor neuron stimulation of left side at time 60 had shown $p>0.05$ in groups 1 and 3, 2 and 4 and 3 and 4. Left Sensory neuron stimulation showed $p>0.05$ at time 20 in groups 2 and 4 and 3 and 4. $P>0.05$ were seen at time 20 in groups 1and 2, 2 and 3, 2 and 4, when right side motor neuron stimulation was performed. Right side sensory neuron stimulation showed $p>0.05$ at time 10 in groups 1and 2, 2 and 3, 2and4.

4. Discussion

Lasers are effective in eliminating pains that are caused by nerve irritation and nociception excitation and neuropathic pain. Photobiochemical reactions of laser is responsible for this effect. Analgesic effects of Low level lasers are used for pain reliving in dentistry to improve maxillofacial pain, for local cannulation and postoperative pains. In addition, Ohshiro and Calderhead believe low intensity laser irradiation may work through effects on the central nervous system. They have suggested this occurs through tissue photobioactivation, in which the energy levels of biological structures are changed through light quantum absorption. Human tissue absorbs light energy and this stimulates and modifies metabolic processes. It results in reorganization of protein polymers. In particular, it changes the structural and functional properties of cell membranes as well as fermentation processes.[5,6,9,10]

Some theories are described for analgesic effects of low power lasers. These are decrease in cell membrane permeability for Na and K cause neuronal hyperpolarization and increased pain threshold.[7] Low level lasers also inhibit the release of mediators from injured tissues. With decrease in chemical agents concentration (histamine, acetylcholine, serotonin, $H+$ and $K+$) decrease in acetylcholine esterase activity result in acetylcholine concentration inhibition.[15]

There is a similarity between epidural and laser function. Epidural block acts with function of drug concentration and its duration appears to be related to its protein binding drug which is responsible for penetration of the lipid membrane, it is the ionic form which is responsible for blocking sodium channels and so interfering with nerve conduction. This can be describe as the synergic effect of low level laser and epidural injection which was seen in horses received both had earlier and more effective ataxia and analgesic function.

The effectiveness of block is a function of drug concentration and its duration appears to be related to its protein binding. Although it is the base form of the drug which is responsible for penetration of the lipid membrane, it is the ionic form which is responsible for blocking sodium channels and so interfering with nerve conduction.

When a drug is administered into the epidural space it must diffuse into neuronal tissue to produce an effect. The drug may leak out through intervertebral foramina, it may get taken up into epidural fat, it may diffuse into nerve roots beyond the meningeal sleeves, and it may be removed by epidural blood flow. It may diffuse into the dorsal roots through the dural cuffs or directly through the meninges to the cerebrospinal fluid and the spinal cord itself. [1,3,14,15]

They cause vasodilatation and increase blood flow to tissues, accelerating excretion of secreted factors. On the other hand, better circulation leads to a decrease in tissue swelling.

Laser decrease tissue edema by increasing lymph drainage. They also remove the pressure on nerve endings, which result to decrease of stimulation. This can be a reason for delayed muscle contraction that were received LLL by TENS machine.[11,7]

Radiating 3000mw laser for ten minutes increased lidocaine epidural analgesic and blockade effect in practice with reasons discussed above although laser radiating did not change the clinical analgesia and sedation significantly. There was no satisfactory difference between the groups in sensory and motor stimulations. We think that is wiser to use low level laser in combination with lidocaine in less dose. It can be useful in preventing side effects of using a full dose or more of epidural drug injection when combine it with analgesia of low level lasers.

One of the weakness of our study was that we couldn't use sedation for straining uncalm horses. So there was a problem in sticking and movement in pocket like bas, keeping the metal plates of TENS machine. Loose of stickiness' and plate movements may have affected the muscle contraction stimulation. Additional research is needed to assess the sensory nerve blockade specifically in radiation dose and drug dose to decrease side effects and producing analgesic effects needed.

We conclude that low level laser in combination with caudal epidural lidocaine treatments provided sufficient analgesia in horses, and this treatment is offered a longer duration of analgesia than laser, lidocaine caudal administration. Low level laser may be effective adjuvants in caudal epidural anesthesia in horses. Our results showed that LLL plus lidocaine may be preferable to a high dose of epidural lidocaine.

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چکیده

ارزیابی اثرات لیزر کم توان بر بی‌حسی اپیدورال در اسب

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هدف: بی‌دردی اپیدورال در طی سالیان در مطالعات مختلف با استفاده از ترکیبات دارویی مختلف برای پیدا کردن نوعی از آن که عوارض قابل‌کنترلی ایجاد کند موردبررسی قرار گرفته است. با ثابت شدن اثرات ضد دردی لیزرهای کم‌توان و بهره‌گیری از آن‌ها در دندانپزشکی با همین کاربرد این مطالعه جهت ارزیابی میزان اثرگذاری لیزر بر بی‌دردی اپیدورال انجام گرفت.

طرح: مطالعه ضربدری تجربی آینده‌نگر تصادفی شده یک‌سویه کور

حیوانات: تعداد پنج اسب سالم با میانگین سنی ۱۵٫۷ -۴٫۹ سال و وزن ۲۴۰ کیلوگرم در این بررسی به کار گرفته شدند.

روش کار: هر پنج اسب چهار نوع درمان را به‌طور اتفاقی در روزهای متعدد با حداقل فاصله زمانی یک هفته دریافت کردند. درمان‌ها شامل: گروه یک -اپیدورال نرمال سالین ۰/۹٪، گروه دو- اپیدورال لیدوکائین ۲ میلی‌گرم/کیلوگرم، گروه سه-اپیدورال لیدوکائین همراه با تابش لیزر کو توان (۳۰۰۰ هرتز- ۱۰ دقیقه)، گروه چهار- تابش لیزر (۳۰۰۰ هرتز-۱۰ دقیقه).

در مورد هر اسب قبل از دریافت هر درمان ناحیه پشت حیوان شیو شده و آماده گردید. اپیدورال در فضای بین اولین و دومین فضای بین مهره‌ای انجام گرفت. از دستگاه تنس الکتریکی جهت بررسی کمی اثرات بی‌دردی بر اعصاب حسی و حرکتی استفاده گردید. صفحه‌های ناقل جریان دستگاه بر محل ابتدا و انتهای عضله سمی تندینوس قرار گرفت. هر اسب جهت بررسی کیفی ازنظر پاسخ به تحریکات دردناک با سوزن زدن در ناحیه پرینه، ایجاد درد با پنس خونبند، وجود عدم تعادل و آرام بخشی بررسی و داده‌های آن ثبت گردید.

نتایج: بررسی میلی‌آمپرهای به‌دست‌آمده از تحریک عضله با دخالت اعصاب حسی و حرکتی ازنظر آماری بین گروه‌ها معنی‌دار نبود. در کار بالینی بی‌دردی و عدم تعادل در گروه سه که علاوه بر اپیدورال لیدوکائین لیزر تابانیده شده بود واضح بود.

بحث: داروهای بی‌حسی موضعی با تأثیر بر نفوذپذیری غشا ایجاد بی‌دردی می‌کنند. ازجمله اثرات لیزرهای کم‌توان تأثیر بر جابه‌جایی سدیم در دیواره سلولی است که علاوه بر دخالت بر تولید ناقل‌های عصبی و مکانیسم پروستاگلاندین به این روش ایجاد بی‌دردی می‌کند. بی‌دردی ناشی از ترکیب تابش لیزر کم‌توان و اپیدورال لیدوکائین می‌تواند به دلیل هم سو شدن اثرات مشابه این دو روش صورت گیرد. معنی‌دار نبودن آماری داده‌های کمی و معنی‌دار بودن کیفی‌ها می‌تواند نیاز بررسی اثر وابسته به دز داروی بی‌حسی موضعی را در ترکیب با لیزر توجیه کند.

کلیدواژه‌ها: بی‌دردی، بی‌حسی موضعی، لیزر کم‌توان، اپیدورال، لیدوکائین، ماشین تنس، اسب