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Comparative Use of Electromyography in the Evaluation of Electroacupuncture and Transcutaneous Electrical Neural Stimulation (TENS) Effect on Regeneration of Sciatic Nerve in Dog

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Abstract

Objective-To determine the effect of Electroacupuncture and Transcutaneous Electrical Neural Stimulation on Regeneration of Sciatic Nerve in Dog

Design - Experimental in vivo study.
Animals - A total of 15 adult male mixed bred dogs, weighing 26±2.6 Kg/BW with aging of 42±6 months, which were divided into three groups of 5 dogs.
Procedures-Under general anesthesia, the right sciatic nerves were exposed and completely crushed using artery forceps within 5 seconds in each dog. No treatment was given to control group, dogs in experimental group (I) were subjected to electro-acupuncture treatment daily for 10 minutes for a period of 15 days by locating BL60, SP9, GB30,and ST36 acupoints using 4 Hwato needles of 0.3×40 mm with 50Hz frequency and 30 to100 mA intensity and dogs in experimental group (II) were subjected to transcutaneous electrical stimulation daily for 10 minutes using four superficial electrodes with 100 Hz frequency and intensity of 80 μs (2.8 ±1.6 mA). Clinical signs were recorded for two months and electromyography was recorded from right semi-membranous, semitendinous, extensors and flexors groups of muscles in normal after crush and on 14, 28, and 45 days.
Results- The right hind limb paralysis was observed in all dogs of three groups immediately after full recovery from anaesthesia. The positive effect of electro-acupuncture and transcutaneous electrical stimulation were observed on second week on skin wound healing and increasing physical activity by improvement and changes in weight bearing and coordination on 3rd week and normal coordination and full weight bearing on 5th week in all dogs of experimental groups. Significant changes in reduction of amplitude in all muscles

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which were persistence in semimembranous and semitendineosus in control group till end of observation period of 60 days were recorded. Significant improvement in amplitude which showed regaining muscle strength in both experimental groups was recorded at the end of 28 days.

Conclusion and Clinical Relevance- Application of electro acupuncture and transcutaneous electrical stimulation for regeneration of neural injuries and regaining muscular function can be recommended in dogs.

Key words- Acupuncture, TENS, Sciatic Nerve, Dog

Introduction

Physical agents are various forms of energy, which are often called modalities and their use forms the basis of the practice for human and animal health care. Therapeutic electrical stimulation has been FDA approved for decades and is used in athletic training rooms, sports medicine clinics and physical therapy clinic[1,2]. The studies in animals have clearly established that various forms of electrical stimulation and electro-acupuncture positively affect the growth, repair and remodeling of hard and soft tissues and often assumed to augment regeneration of various tissues. It has been advocated for the symptomatic relief and management of chronic, intractable pain and as an adjunctive treatment in the management of post surgical and post–traumatic pain conditions[3,4,5,6]. As the successful treatment of peripheral nerve injury is quite challenging and the prolonged sternal or lateral recumbency usually renders animals susceptible to different musculoskeletal disorders including neural degeneration, neural tissue regeneration and its full functional capacity research have received clinically due attention[7]. In this study, the comparative effects of the transcutaneous electrical neural stimulation (TENS) and acupuncture therapy were evaluated in regards to restoration of skeletal muscle power following experimentally induced sciatic nerve injury in dog.

Materials and Methods

This study was conducted on 15 adults male mixed bred dogs, weighing 26±2.6 Kg with the age of 42±6 months. The dogs were kept under standard management condition with free access to food and water. They were vaccinated and dewormed. All dogs were fasted for 24 hours. Premedication was achieved by using a combination of ketamine hydrochloride (Ketamine, 100 mg/ml, Aesculaap, Boxtel, Holland), diazepam (Diazepam, 5 mg/ml, Phoenix Pharma LTD., Gloucester, UK), and atropine sulfate 15 minutes before induction of anesthesia. Thiopental sodium (10 mg/Kg) was injected intravenously to induce anesthesia and an effective depth of anesthesia was maintained using halothane 1-2% during surgery. The medial- lateral side of the right femor was clipped and prepared for aseptic surgery. The right sciatic nerve was completely exposed and crushed by a medium size artery forceps for 5 seconds (fig.1). Incisions were sutured as routine. Dogs were randomly divided into three groups (a control & two experimental) of 5 dogs each. No treatment was given to control, whereas; dogs of the first experimental group were subjected to electro-acupuncture therapeutic regimen daily for 10 minutes for 15 days by locating acupuncture points GB 30 (gall bladder, Shao Yang) connected to ST 36 (stomach ,Yang Ming) and Sp 9 (spleen ,Tai Yin) connected to BL60(bladder, Tia Yang). Needles employed were 4 Hwato needles of 0.3 mm in thickness and 40mm in length. Current was run at 50 Hz frequency and 3 to 10 mA intensity (fig.2), using instrument WQ-6F (57-6F) Electronic Acupunctoscope (WQ-6F (57-6F) Electronic Acupunctoscope Model Beijing Haidian District Dounghua.Electronic

Instrument Factory, China). Dogs of the second experimental group were subsequently subjected to TENS therapeutic regimen (Newtens 900C ,Novin Co., Isfahan, Iran) (fig.3) daily for 10 minutes using four-surface electrodes with 100 Hz frequency and intensity of 80 μs (2.8±1.6 mA) (fig.4). Clinical signs were recorded for two months and EMG was recorded from the right semimembranous, semitendineous, extensors and flexors groups in normal, after crush, and on 14, 28 and 45 days from all dogs of three groups (fig.5).

Fig. 1: Completely exposed sciatic nerve with the site of crush.

Fig. 2: Location and insertion of needles at the site of acupoints.

Fig. 3: Electrical Stimulation Apparatus (Newtens.900C. Novin Co.Isfahan.Iran).

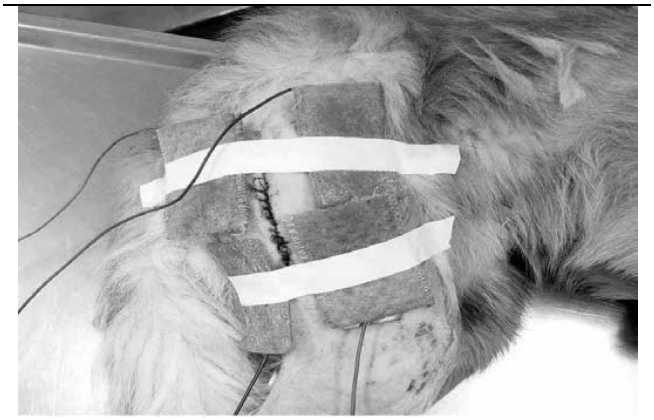

Fig. 4: Fixation of surface electrodes on the either side of skin incision.

Fig. 5: Fixation of superficial electrodes for electromyography recording.

Statistical Analysis

The statistical software, SPSS Version 9.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for analysis (ANOVA and Tukey tests). A level of $P<0.05$ was considered as significant.

Results

All dogs showed paralysis of the right hind limb and dragging the limb while walking after being fully recovered from anesthesia. Variable local swelling and tenderness was noted at the site of the incision till the end of first week in all dogs. Both the acupuncture and TENS treated groups were ambulating more successfully in the second week and having more stable coordination than the control group. There was marked reduction in local swelling, pain and tenderness besides showing better skin wound healing in treatment group. There was less scar tissue formation after removal of sutures in both experimental groups. In acupuncture group two dogs had full weight bearing on the 3rd week and three others, by the end of the 5th week ,whereas; in TENS group, four dogs showed full weight bearing on the 3rd week and one dog by the end of the 5th week. Lameness and incomplete weight bearing was present in all dogs of the control group until the end of the clinical observation period of 60 days. Electromyography (EMG) recording showed significant improvement in regaining muscular function in the semimembranosus and semitendineosus muscles in both experimental groups. There was significant improvement in these muscles treated with TENS as compared with acupuncture one (figs. 6 and 7). There was also a significant reduction in amplitude in all muscles which was persistent in semi-membranous and semitendineosus in control group till the end of the observation period of 60 days ($P<0.05$). There were no significant changes in extensor and flexor muscles in all three groups.(figs.8 and 9)

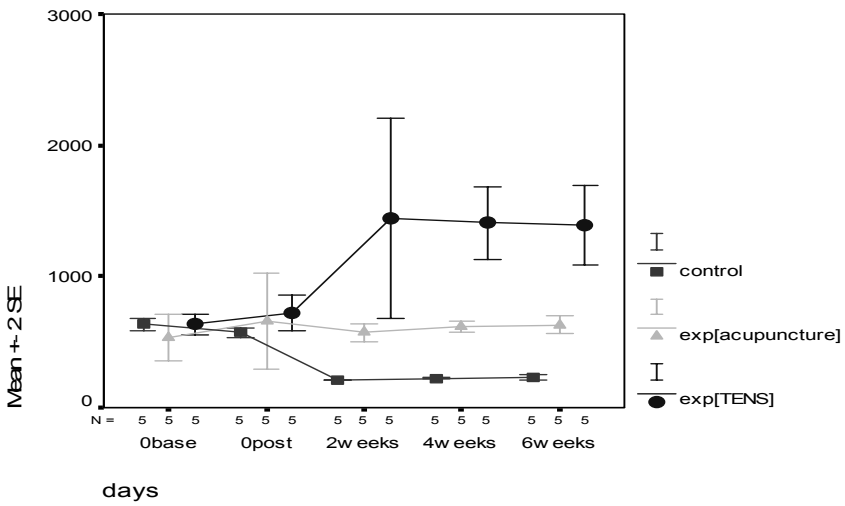

Fig. 6: Semitendinosus muscular function changes in both control and experimental groups

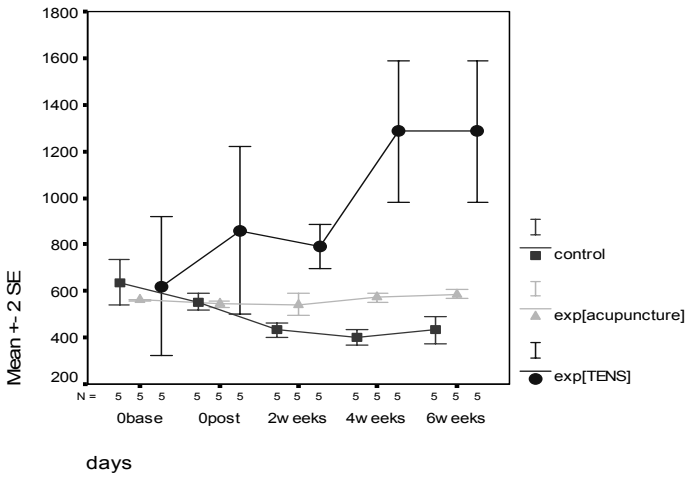

Fig. 7: Semimembranosus muscular function changes in both control and Experimental groups

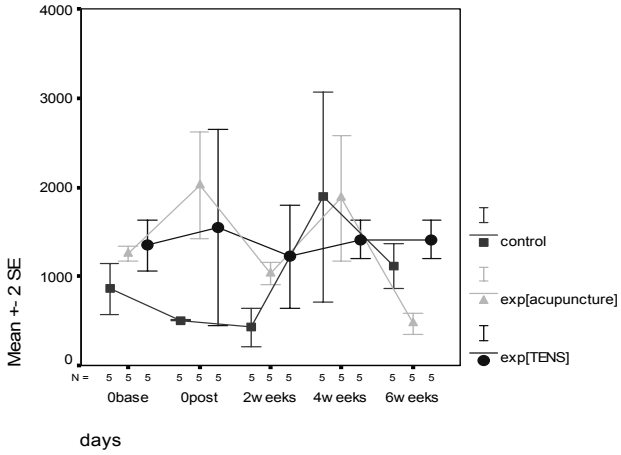

Fig. 7: Semimembranosus muscular function changes in both control and experimental groups.

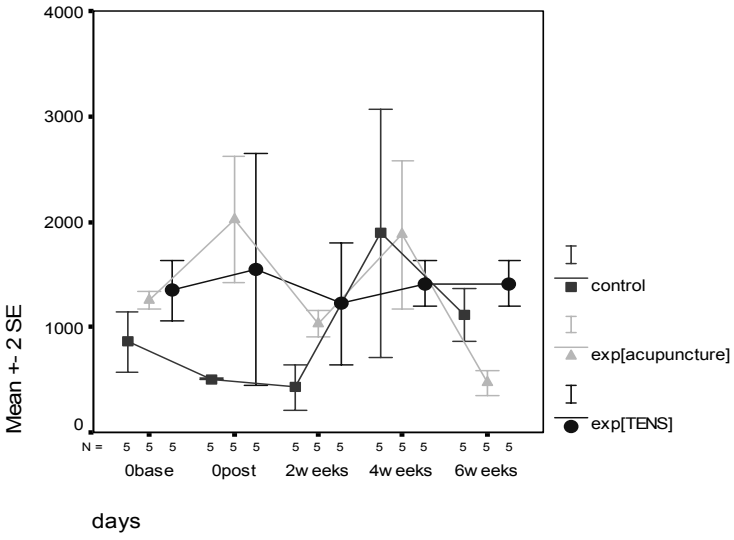

Fig. 8: Extensor muscular function changes in both control and experimental groups.

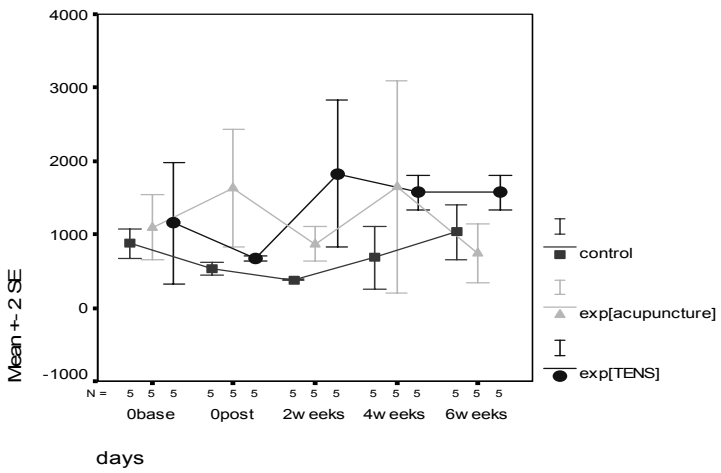

Fig. 9: Flexor muscular function changes in both control and experimental groups.

Discussion

The results of this experiment show the effectiveness of TENS and acupuncture in controlling pain. They can actually accelerate wound healing as it was observed in both treated groups with TENS and acupuncture therapeutic regimens[3]. There are several recent studies supporting the beneficial effects of treating wounds with an artificial current[1]. Experimental animals wound models in 1960's demonstrated that electrical intervention results in accelerated healing with skin wounds resurfacing faster, and with strong scar tissue formation[4,7]. It is obvious that full weight bearing is the primary goal of surgical intervention, but timely application of such physical modalities to be effective in early abolishment of clinical inflammatory signs, tends to increase the amount of growth factor, having main role in tissue regeneration, in the form of increasing the amount of collagen formation, is also very important[8] and their application definitely will have positive effects on the muscular and neural repair[8,9,10,11]. Electro-acupuncture has local effects on reduction of pain and swelling during surgery and post operative rehabilitation[12,13]. It has been highly recommended for orthopedic disorders[14,15,16] because of increasing local blood flow which is considered as one of the main factors in cellular activity in the stimulated tissue[17] and also increases the secretion of morphine like substances (endorphin and serum cortisol level). This is also true about TENS by targeting sensory nerves, stimulating them to block pain signals and prevent their transmission to the brain. Their concurrent application promote production of endorphins, the body's natural pain reducing substances, being used to treat back and cervical muscular and disc syndromes, arthritis, shoulder syndromes, neuropathies and painful conditions[2,5,18]. It can counteract negative side effects of muscular injuries (fluid accumulation) through neuromuscular stimulation (NMS) and strengthen the injured area by removing excess fluid and increasing blood flow to the site, and encouraging rehabilitation via increase in ATP and enhancing amino acid transport and protein synthesis in the treated area[8,19]. Reports from quoted researches prove that electro-acupuncture stimulates internal factors to induce naturally present pain killers and reduce or abolish pain in the body[20,21]. Presently, different peptide materials having morphine like properties to reduce pain have being recognized and identified in the body[22,23]. Some reports state that there is more than one neurophysiological pathway to reduce pain while using electro-acupuncture[5,8]. Different characteristics of stimulatory signals like shape of wave, pulse, frequency and amplitude can impact reduction of pain[20,21].

In this study the application of TENS and electro-acupuncture on the site of a nerve injury are shown not only have gross improvement on muscle mass, but also there was significant improvement in muscular power in the semitendinosus and semimembranous, 45 days after surgery[24]. It seems that these muscles are directly under the influence of the sciatic nerve and application of these physical modalities could reduce gross atrophy and increase local mass muscular function[12,25,26,27,28]. The similar finding was reported in daily application of electrical stimulation on rats for 8 weeks. The rats demonstrated an increased diameter and muscle mass with the acupuncture. The use of stimulation immediately after nerve injury maintain the integrity of the muscle fibers and hence, their potential functional capacity which indicated faster return of muscle strength as shown in EMG recordings in this study[15,29,30]. Another report stated that electrical stimulation can be effective on regeneration of spinal nerve injury and generation of motor-sensory specificity, besides increasing muscle strength (muscle force) and even endurance (fatigue resistance)[23,27,28,31]**.** In another study the using a type of systemic internal stimulator compared to electrical stimulation of a nerve injury in the rat, the electrical group had better muscular gain than control systemic one[8]. Using electrical current stimulated faster regaining of muscle power in the psoas muscle after inducing experimental nerve injury[8]. Using direct current for regeneration and repair of sciatic nerve had a positive effect even after complete separation of the nerve with an end to end anastamosis[22].

The findings of this study were similar to findings reported by quoted authors. TENS and electro-acupuncture are helpful by regeneration and repair of severed nerve. They increase the sensitivity and muscular power in semitendineosus and semimembranosus muscles. This stimulation could clinically prevent further muscular atrophy[32]. The benefit of TENS and electro-acupuncture has been reported in a lamb[33] and in a dog with severe discopathy at the thoracolumbar region compared to surgery and conservative methods of treatment[31], and in perineal nerve paralysis in the human being[21]. Significant changes in muscular power in the semitendineosus and semimembranosus muscles were recorded in EMG in this study after experimentally induced sciatic nerve injury. This study further proves the usefulness of TENS and electro-acupuncture in regeneration and repair of a peripheral nerve and the restoration of muscular function**.** The TENS therapeutic regimen revealed that, besides reduction in pain, swelling, and lameness, had significant positive effect on prevention of gross atrophy of the muscles at the region as compared with acupuncture. According to the findings of this study TENS and electro-acupuncture can be recommended during neural regeneration and regaining muscular ability in dogs.

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چکیده

ارزیابی مقایسه ای الکترو میوگرافی اثرات تحریکات الکتریکی و طب سوزنی در رژنراسیون عصب سیاتیک در سگ

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هدف: بررسی اثرات تحریکات الکتریکی و طب سوزنی در رژنراسیون عصب سیاتیک در سگ
طرح: تجربی در حیوان گوشتخوار
حیوانات: ۱۵ قلاده سگ بالغ نر از نژاد مخلوط با میانگین وزن ۶/۲±۲۶ کیلو گرم و سن ۰/۶ ± ۴۲ ماه انجام گرفت.
روش کار: تحت بیهوشی عمومی عصب سیاتیک راست در تمام حیوانات با استفاده از پنس خونبند درمدت ۵ ثانیه تحت فشار برای له شدن کامل قرار گرفت و سپس این حیوانات به سه گروه کنترل (I) آزمایش (II) و آزمایش (III) با ۵ حیوان در هر گروه تقسیم شدند. در گروه کنترل هیچگونه درمانی صورت نگرفت در صورتیکه در گروه آزمایش (I) بعد از مشخص کردن نکات طب سوزنی در قسمت سمت جانبی ران راست بنام GB 40,ST 36,SP 9, BL60 با فرکانس ۵۰ هرتز و شدت ۱۰-۳ میلی آمپر به مدت ۱۰ دقیقه در روز برای ۱۵ روز با استفاده از دستگاه WQ-6F (57-6F)تحت درمان قرار گرفتند و حیوانات گروه (III) تحت تحریکات الکتریکی با استفاده از دستگاه (Newtens 900 C) با فزکانس ۱۰۰ هرتز و شدت ۸۰ میکرو ثانیه (۱/۶±۲/۸ میلی آمپر) برای ۱۰ دقیقه در روز به مدت ۱۵ روز قرار گرفتند. در مدت زمان مطالعه دو ماهه مشاهدات بالینی ثبت گردید و در روزهای ۱۴و۲۸و۴۵ از تمام حیوانات الکترو میوگرافی از مجموعه ماهیچه های باز کننده و خم کننده و نیمه غشائی و نیمه وتری پای راست اخذ گردید.
نتایج: بلافاصله بعد از به هوش آمدن تمام حیوانات فلجی کامل پای راست را نشان دادند و در هفته اول از حساسیت درد و تورم موضعی برخوردار بودند. فعالیت فیزیکی خوبی هر دو گروه درمان شده در هفته دوم مشاهده گردید کاهش درد حساسیت و تورم موضعی و شروع وزن گیری در هر دو گروه درمان شده در هفته دوم درمان محسوس بود در صورتیکه لنگش در گروه کنترل تا پایان دوره مطالعه ثبت گردید افزایش قدرت انقباض عضلانی در عضلات نیمه غشائی و نیمه وتری در هر دو گروه آزمایش در هفته سوم و چهارم از نظر آماری معنی دار بود, بطوریکه گروه تحریکات الکتریکی (III) از افزایش قدرت عضلانی بهتری بر خوردار بود و در مجموعه عضلات باز کننده و خم کننده تغییرات معنی داری مشاهده نگردید.
نتیجه گیری: بر اساس نتایج حاصل از این مطالعه مي توان اظهار داشت که استفاده از تحریکات الکتریکی و طب سوزنی می تواند در افزایش قدرت عضلانی در هنگام آسیب دیدگی عصب موثر و مفید باشد.
کلید واژگان: تحریکات الکتریکی, طب سوزنی, عصب سیاتیک, رژنراسیون سگ