

## A Comparative Histopathological Evaluation of Neuroma Formation Through the Guillotine and Epineural Capping Neurectomy Techniques in Horse

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**Abstract:** Two methods employed for palmar digital neurectomy are the guillotine and epineural capping techniques. The present investigation was primarily conducted to compare the histopathological effects of the techniques mentioned above. Ten Guillotines and the Epineural capping neurectomy were performed bilaterally in ten horses (five horses in each group). The nerve ends were evaluated microscopically after 60 days of surgery. The outcomes of study suggest that the guillotine technique has a lower incidence of painful neuroma formation than epineural capping technique and it also has the advantages of shorter surgery time, less expense and lower incidence of re-innervation. We presume that the guillotine method produced less painful neuromas because, through the guillotine method of neurectomy, the nerve was sharply transected and stretched from the surgically traumatized tissue.

**Key words:** Neuroma · Guillotine · Epineural capping · Neurectomy · Horses

### INTRODUCTION

Neurectomy of the palmar digital nerves is occasionally required to provide the horses suffering chronic heel pain [1]. A variety of diseases or syndromes can cause to chronic heel pain, the most common of which is pain in the region of the navicular bone and sometimes palmar digital neurectomy is the final way to eliminate pain in this region [1]. Navicular syndrome, distal phalangeal fractures, calcification of the collateral cartilages of the distal phalanx and fractures of the navicular bone causes pain in the navicular area will be created and these diseases are indications for palmar digital neurectomy but Navicular syndrome is the most common indication for palmar digital neurectomy [2-5]. Transection of the palmar digital nerves is suggested to desensitize the palmar aspect of the foot, relieving the pain associated with the area [2]. The postoperative complications of the neurectomy, including painful neuroma formation, regeneration of the transected nerve and incomplete desensitization of the heel or navicular area from aberrant branches [6,7] but the most common complication of

neurectomy is the painful neuroma [2]. Following partial or complete interruption of the schwann cells and endoneurium, the interrupted axons begin to proliferate and regenerate. Without intact endoneurial tubes to guide their growth, the branching, disorganized mass of axons, fibroblasts and schwann cells soon form a neuromatous bulb on the nerve [8]. When a painful neuroma is dissected from its surrounding tissue, often one or more funiculi can be seen extending from the bulb and into the surrounding tissues [8]. Various surgical techniques have been described, each with the aim of reducing the incidence of painful neuroma [2]. These techniques include guillotine transaction, silicone capping and epineural capping of the nerve, cryoneurectomy, laser neurectomy, injection of neurotoxic agents, stainless steel ligature and intramedullary anchoring of the nerve [2]. Guillotine transaction and epineural capping are the most techniques used. The purpose of this study was to histopathological evaluating the outcome of painful neuroma formation of using the guillotine and epineural capping techniques for palmar digital neurectomy in horse.

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## MATERIALS AND METHODS

Ten healthy adult horses from 2 to 8 years of age were used. All animals were kept in single box during the whole experimental period, under similar conditions and maintained with similar diet. Animals were divided into two groups, with five horses in each. Ten guillotine neurectomy techniques were performed bilaterally in five horses of group 1 and ten epineural capping neurectomy techniques were performed bilaterally in the five horses of group 2.

**Surgical Procedures:** The horses were sedated prior to surgery using Xylazine (Xylazin 2%, Alfasan, Worden-Holland, 1 mg/kg, IV). Anaesthesia was induced with Ketamine hydrochloride (Ketamine 10%, Alfasan, Woerden-Holland, 2 mg/kg, IV). The horses were positioned in lateral recumbency on a surgery table. Medial and lateral palmar digital nerve analgesia was performed bilaterally at the mid-pastern level using 3 mL lignocaine.

**Guillotine Technique:** A 3 cm skin incision was made, parallel and axial to the palmar digital nerve. The jaws of a curved hemostat were used to separate the subcutaneous tissues and to expose and isolate the palmar digital nerve from the adjacent palmar digital artery. After identification, the nerve was elevated from its bed and the distal portion was transected sharply using a scalpel blade. Hemostats were then placed on the proximal end of the transected nerve to allow traction over a sterile tongue depressor. The nerve was transected under tension about 2.5 cm long using a razor blade so the proximal end recoiled proximal to the incision.

**Epineural Capping Technique:** As in the guillotine technique, the surgical dissection and exposure of the nerve were accomplished. A section of nerve 3 to 4 cm long was exposed and freed from all fascia, connective tissue and palmar digital artery. The nerve was severed as distally as possible and raised from the incision. The end of the nerve was then held with forceps and the epineurium was carefully reflected for 2 to 3 cm. Two incisions were made through half the nerve on each side. The nerve was then severed distal to these cuts and the epineurium was pulled back over the severed end and was ligated with #3/0 polypropylene suture.

The surgical site was flushed with sterile saline and closed using a simple continuous layer of #2/0 polyglactin 910 in the subcutaneous tissue and simple interrupted

sutures of #0 nylon in the skin. Following the surgery, a padded pressure bandage was applied extending from distal to the coronary band to the proximal cannon bone region. The bandage was changed every 5 days for 2 weeks. All the horses received procaine penicillin (20 mg/kg/3 days, IM) and Phenylbutasone was administered (4.4 mg/kg/3 days, IV).

**Histopathology Evaluation:** After 60 days, the samples from nerves were obtained from each surgery site under general anesthesia, which included proximal and distal nerve ends. Serial sections were cut and stained with Haematoxylin and Eosin (H&E) method and used for light microscopic examination under a Nikon microscope (ECLIPSE E200, Japan) to histopathological evaluation. The nerve ends were evaluated microscopically to assess nerve regeneration, neuroma formation and fibrosis.

## RESULTS

In the epineural capping technique, multiple tangled and interwoven neurofibrils have been separated by dense fibrous tissue of the nerve sheath. Schwann cells, supporting the nerves are observed. Abundant nerve tissues suggest a painful neuroma (Fig. 1). In guillotine technique unencapsulated mass of numerous variable sized bundles characterized by neurons as small as red dots (arrows), clear myelin sheath spaces and spindling

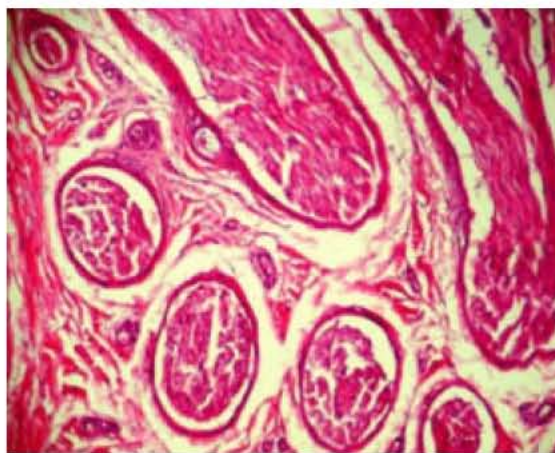


Fig. 1: Microscopic view of the neuroma formation after neuronal transaction with epineural capping technique. Multiple tangled and interwoven neurofibrils have been separated by dense fibrous tissue of the nerve sheath. You can see the Schwann cells, which support the nerves. Abundant nerve tissue suggest a painful neuroma (hematoxylin-eosin, x250).



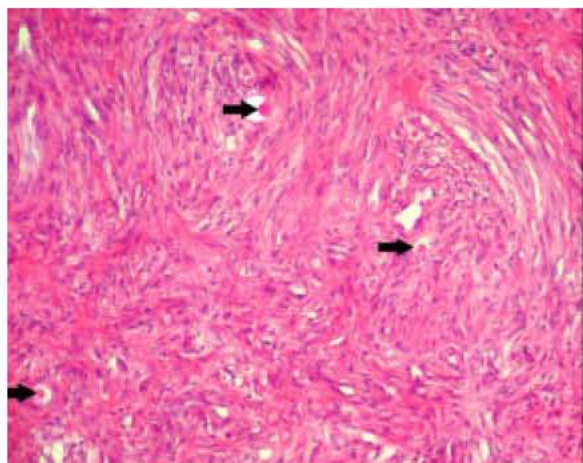


Fig. 2: Microscopic view of the neuroma formation after neuronal transection with guillotine technique. Unencapsulated mass of numerous variable sized nerve bundles characterized by neurons as small red dots (arrows), clear myelin sheath spaces and spindling Schwann cells supported by large amounts of collagenous fibrous tissue. Chronic inflammatory cell infiltrate are present. Abundant fibrous connective tissue and little nerve tissue suggest a chronic and insignificant lesion (hematoxylin-eosin, x250).

schwann cells supported by large amounts of collagenous fibrous tissue. Infiltration of chronic inflammatory cells are present. Abundant fibrous connective tissue and little nerve tissue suggest chronic and insignificant lesion (Fig. 2). The scores obtained for nerve regeneration, schwann cell deterioration and neuroma formation were lower for guillotine neurectomy compared with the epineural capping neurectomy. In fact, guillotine neurectomy had a lower score for neuroma formation and nerve regeneration.

#### DISCUSSION

The most common indication for palmar digital neurectomy is to obviate pain associated with navicular syndrome [2-5]. Lameness associated with painful neuroma formation is the most complication after neurectomy [2] and a frustrating problem for the surgeon. Jackmann reported in 34% of horses that palmar digital neurectomy were used by guillotine or electrocautery techniques, lameness had returned by painful neuroma formation or a return of sensation existed [4]. In another study, Dabareiner showed that guillotine method produced less painful neuromas than perineural capping,

CO<sub>2</sub> laser coagulation and CO<sub>2</sub> laser transection [7]. Another common complication after neurectomy is re-innervation due to regeneration of the palmar digital nerves [4,6,9]. Clinical studies have shown that removal of a 2 to 4 cm section of nerve decreases the likelihood of successful re-innervation and increases the time before this occurs [6]. Histopathological results of this study showed that nerve regeneration, schwann cell deterioration and neuroma formation were lower for guillotine neurectomy. The main reason for no formation of painful neuroma in the guillotine neurectomy technique was sharply transected of nerve and stretched and therefore, removing 2 to 4 cm, the proximal portion retracts proximally, away from the surgically traumatized tissue and less inflammation postoperatively in this method caused minimized the incidence of painful neuroma formation.

In conclusion, the guillotine technique has a lower incidence of painful neuroma formation than epineural capping technique in histopathologically evaluations because the nerve was stretched and proximal stump to withdraw into tissue less affected by surgical trauma.

#### ACKNOWLEDGMENT

The authors would like to express their thanks to the personnel of the clinical science department of veterinary medicine faculty, Islamic Azad University-Tabriz Branch, who were present during this study.

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