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Standing Laser Surgery in the Horse

John H Burford * MA VetMB MRCVS

College of Veterinary Medicine, University of Liverpool, Liverpool, UK.

Abstract

For many years, the use of laser energy sources has been a highly advocated technique in equine upper respiratory surgery, yet has remained beyond the use of the vast majority of general practitioners. Previous limitations have included cost, but also the requirement for special training and the large size of equipment restricting their value to most veterinarians. The development of gallium aluminium arsenide (GaAlAs) diode lasers has resulted in small portable units which are steadily becoming more affordable as these instruments are more widely adopted. Laser surgical techniques are more commonly replacing traditional surgical methods. Advantages include avoidance of the risks associated with general anaesthesia, reduced surgical morbidity and rapid post-operative recovery. In addition, laser surgery presents a method of accurate surgical dissection with inherent haemostasis minimising the risk of intra-operative bleeding.

Introduction

The term laser is an acronym for “light amplification by stimulated emission of radiation”. Laser energy has a number of characteristics: it is coherent with all waves in phase in space and time; it is collimated and thus highly directional; and it is monochromatic of a single wavelength. Furthermore, surgical lasers are of high energy with diode sources typically having an output power of 15-25 watts. Lasers were introduced in to the medical field during the 1960s, and currently a number of surgical lasers are available with more superseded by more practical technologies.
The tissue effect of lasers is dependent on a number of factors. The wavelength of the laser energy is important with long wavelength sources such as the carbon dioxide laser (10600nm) rapidly dispersing energy into tissue and water. These therefore have very shallow tissue penetration, typically 0.01mm. Diode laser sources operate at shorter wavelengths and may show tissue penetration up to 5mm which has implications for thermal necrosis adjacent to the surgical field. The exposure time of the tissue to the energy source and the power of the laser energy also affect the destruction of tissues, as

* **John H Burford**
Philip Leverhulme Equine Hospital, Leahurst, Neston, Cheshire, Ch64 3RX
E-mail: John.Burford@liverpool.ac.uk

well as the local blood supply of the region. Finally, the method of application has important implications with a contact technique between the fibre optic cable and the tissue being advocated to ensure accurate control of the laser output.
The use of lasers requires a means of delivery of the energy using fibreoptic cables. At a simple level, laser scalpel devices are available which are particularly applicable to cutaneous surgical techniques, particularly tumour removal. More commonly, lasers are used in upper respiratory surgery with fibreoptics placed through the biopsy channel of endoscopes in order to reach the surgical field. The first commercially available device was the Neodymium:Yttrium aluminium garnet (Nd:YAG) laser. More recently GaAlAs diode lasers have entered the veterinary market and, although they remain expensive, are significantly more affordable and offer portability. Today, the laser is an established instrument in many upper airway procedures. It offers more accurate dissection of tissues with its inherent haemostatic properties limiting tissue bleeding and post-operative complications. Furthermore, in many circumstances anaesthesia can be avoided resulting in lower morbidity procedures associated with a quicker return to athletic activity.

Materials and Methods

Veterinary Lasers

Until approximately 10 years ago, the Nd:YAG laser was the most commonly used laser source in the veterinary field. Nd:YAG lasers produce a monochromic source of 1064nm which is not absorbed by water, but is equally absorbed by melonin and haemoglobin. The laser energy disseminated through body tissues may cause latent thermal necrosis; however, it has been reported that coagulation will occur in vessels up to 4mm in diameter[1].
Diode lasers offer several advantages and are becoming widely adopted in preference to Nd:YAG lasers. Their semiconductor design results in small and portable units which can run off normal electricity supplies. In the veterinary market they are typically available in 810nm, 940 or 980nm wavelengths corresponding to specific absorption peaks of haemoglobin. Typically they have a limited power output of 25W; however their high efficiency negates the requirement for extensive cooling mechanisms. Both Nd:YAG and diode lasers can transmit the light energy via inexpensive quartz fibres.

Laser Safety

Surgical lasers are classified as class IV products. All personnel within the operating area must be aware of the dangers which may result not only from direct exposure, but also as a result of reflection. Appropriate eyewear consisting of special filters specific for the wavelength of the laser source should be worn at all times. Ideally a specially designated, lockable room should be used with signs to warn against inadvertent entry and blinds to guard against accidental exposure. The collimated nature of laser energy means that damage can occur to individuals a significant distance from the source.
Endoscopic applications must be performed whilst wearing appropriate eye shielding, especially using fibreoptic equipment. In general, video endoscopy is recommended but it is important to ensure that the equipment is suitable for laser applications. Video

endoscopes will certified such that they will not "whiteout" when the laser is activated. A biopsy channel of at least 2.7mm is required for passage of fibre optic cable. Appropriate scopes will also be fitted with a metal or ceramic plate at the tip which helps to minimise thermal damage. It must also be noted that the laser should never be activated if the fibre optic tip cannot be visualised.
Finally appropriate safety equipment for dealing with fires is also required.

Support Equipment

Beyond the laser source, a number of other essential pieces of equipment are required. These would normally include laser scalpels which allow the fibre optic cable to be hand held. Stripping and cutting guides are available to create an appropriate clean tip for surgical work.
In addition, certain surgical applications require specific instruments. When performing trans-endoscopic procedures, tissue manipulation is often critical. For procedures such as vocal cordectomy, bronchoesophageal grasping forceps are required to adduct the vocal fold to gain access to the ventral and abaxial borders. The author's preference is to use locking forceps (60370 UC, Karl Storz) allowing greater tissue control. Instruments should be pre-shaped to follow the contour of the nasal meatus. For other procedures, endoscopic snares can be used to stabilise and manipulate tissues although this requires a second endoscope.

Discussion

Following purchase of a new laser, writing from personal experience, it is very tempting to try using it in every conceivable situation. It is important to recognise those surgical procedures which can be performed with greater success using often more simple techniques, for example entrapment of the epiglottis by the aryepiglottic fold[2]. It is likely that more applications will continue to be developed in the future.
As previously discussed there are a number of applications in which laser surgery confers major advantages over traditional procedures. In equine surgery these are almost exclusively confined to the upper respiratory system although techniques have been described for other procedures including palmar digital neurectomies[3], distal tarsal joint arthrodesis[4,5] and ocular surgeries[6,7].

Cutaneous Tumour Removal

This is a very common laser technique used in the author's hospital. Advantages over conventional techniques include improved haemostasis compared to sharp dissection but also latent thermal necrosis of the resected margins. Laser energy interacts with tissues in one of four methods: transmission, absorption, scattering and reflection. The predominant interaction is determined by the wavelength of the laser source[8]. Absorption of the laser energy results in vapourisation, with a surrounding area of carbonised tissue. Beyond this region, thermal necrosis will generate a margin of tissue destruction beyond the plane of resection; this may be desirable during the removal of invasive tumours.

Vocal Cordectomy and Ventriculectomy

Following cutaneous tumour removal, this is probably the most common application of laser surgery in the author's hospital. This technique is preferred to the standard surgical technique for ventriculectomy (sacculectomy) via a laryngotomy incision as it is non-invasive and requires no general anaesthesia. During the procedure, haemorrhage is the most commonly encountered complication and it is important to take care not to extend the incision to the abaxial surface of the vocal fold where there are many blood vessels. An excellent description of the surgical technique is provided by Ducharme[9], and is also available online[10]. This procedure may be combined with prosthetic laryngoplasty. As a sole procedure, laser ventriculocordectomy has been shown to be effective at reducing airway noise and improve performance in horses with recurrent laryngeal hemiplegia[11,12]. It should be noted that severe laryngeal swelling may occur post-operatively, and it is important to have close monitoring and tracheotomy equipment available.

Dorsal Displacement of the Soft Palate

Laser cautery of the caudal aspect of the soft palate has been advocated as a potential treatment of dorsal displacement of the soft palate (DDSP), and may be combined with sternothyroid tenectomy[13]. Currently there is insufficient evidence based medicine to determine whether this is any more effective than conservative treatment[14]. Prior to cautery, the pharynx is irrigated with local anaesthetic solution. The technique involves the 1-2 seconds of contact application of the bare laser fibre to the free border of the soft palate. These should extend rostrally for 3-4cm, each spread by 2-4mm. Haemorrhage commonly occurs adjacent to the epiglottis.

Progressive Ethmoid Haematoma

Laser treatment has been advocated for treatment of progressive ethmoid haematoma, which may in part be due to the lack of a definitive treatment protocol. The use of lasers is restricted as with other methods by access, but may be useful for lesions in the middle nasal conchae[15]. If this technique is used without prior injection of formalin solution a high wattage laser is required delivering high energy levels (30,000 to 40,000J) to thermally debulk the laser. This is a substantial undertaking with the lower power laser diode sources.

Respiratory Masses

Reasonable success can be achieved with laser surgery in the treatment of respiratory masses, even those deep within the bronchi. Care must be taken to minimise the risks of thermal necrosis of adjacent structures, and it is important to remember that even the locally heated air may reach sufficient temperatures to result in mucosal injury. Some highly specialist endoscopy systems have a second channel to allow removal of the smoke plume and heated gases by suction. Alternatively the application of laser energy should be intermittent to minimise this heating effect.

Complications

It is important to recognise that all of the treatments described above have the potential for incomplete correction, and recurrence may occur. Clients should be made aware that repeated attempts may be required. One common reason for surgeries having to be aborted and completed at a later date is haemorrhage which can significantly impede visualisation. In general the techniques discussed above are not associated with severe morbidity, but close monitoring should be employed post-operatively in case of respiratory obstructions.
It should be noted that upper respiratory surgeries performed under standing sedation are considered significantly safer than those performed under general anaesthesia. This is in part due to the inherent risks of general anaesthesia, but also due to the risk of working in the vicinity of pure oxygen with its inherent fire risks.

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