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Moffett's muted mules: the science of laryngology in the art of war

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Abstract

Background. Mules and other equine species have been used in warfare for thousands of years to transport goods and supplies. Mules are known for 'braying', which is disadvantageous in warfare operations. This article explores the fascinating development of surgical techniques to stop military mules from braying, with particular emphasis on the key role played by the otolaryngologist Arthur James Moffett in devoicing the mules of the second Chindit expedition of World War II.

Method. The PubMed database (1900–2017) and Google search engine were used to identify articles related to devoicing mules in the medical and veterinary literature, along with information and images on the Chindit expedition.

Results. This paper reviews the surgical techniques aimed at treating braying in mules, ranging from ventriculectomy and arytenoidectomy to Moffett's approach of vocal cordectomy.

Conclusion. Moffett's technique of vocal cordectomy provided a quick, reproducible and safe solution for devoicing mules. It proved to be advantageous on the battlefield and demonstrated his achievements outside the field of medicine.

Review Article

Dr V Sekhar takes responsibility for the integrity of the content of the paper

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Introduction

Horses, mules and other equine animals have been used in warfare for thousands of years. During the early part of the twentieth century, when motorised military vehicles were in short supply, mules were used to transport goods and supplies, particularly in mountainous and muddy terrain. During World War I, 213 300 mules were used by the British and the US armies.[1]

Mules are known for 'braying' loudly, which can be disastrous in covert and guerrilla warfare operations. In this paper, we review the fascinating development of surgical techniques to stop military mules from braying, with particular emphasis on the key role played by otolaryngologist Arthur James Moffett in devoicing the mules of the second Chindit expedition of World War II.

Materials and methods

The PubMed database (1900–2017) was used to identify articles related to silencing mules in the medical and veterinarian literature. The British Imperial War Museum and Internet searches using Google provided further information and images on the Chindit expedition.

Results and discussion

Use of mules in warfare

Mules are a hybrid product of a female horse and a male donkey. Male mules are known as Johns, and female mules are referred to as Mollies or Mare Mules. While light horses have traditionally been used for cavalry and heavy horses have been used to transport artillery on the battlefield, the main role of the mule has been for transporting supplies behind the front lines.

Mules have several characteristics that make them ideally suited to this role. Mules are able to carry more weight than horses, with a 55 per cent front leg weight distribution in comparison to 65 per cent seen on horses. This characteristic, in addition to their compact and tough hooves, makes them very well balanced and surefooted in rugged terrain.

Mules have a calmer temperament than horses and are easier to manage. By way of example, mules will readily follow a mare that is wearing a bell. At the end of the day, when the bell is removed from the mare, the mules will dissipate while maintaining a nearby distance to the mare.[2]

Unlike horses, mules do not readily lose moisture through sweat, instead extracting moisture through their faeces. This appears to be a consequence of inheriting the donkey's desert adaptations. Similarly, mules are able to digest dry inedible desert shrub and extract what little moisture is present within it. A lean body mass in conjunction with woolly hair insulates them from the extremes of temperature and makes them fuel-efficient.

Their large funnel shaped ears serve to amplify distant sounds and dissipate heat, while also acting as a visual communication system to convey danger or asinine moods. It is for all these reasons that mules were considered the ideal pack animal in military campaigns.

'Braying': what to do?

'Braying' is a voluntary piercing sound produced by donkeys and mules. It functions to help them: communicate with each other over vast distances, define their territories, and distinguish members of the same species from other Equidae sharing a common territory under feral conditions.[3] In other circumstances, mules often bray to each other when in danger. Unfortunately, braying by mules is problematic in covert guerrilla operations, as the loud sound is transmitted many kilometres and alerts the enemy to the position of oncoming troops.

In order to combat this issue, armies employed various techniques to devoice mules and render them silent. Unfortunately, many of these techniques led to multiple unintended consequences. Francis William Geoffrey Turner, an animal transport officer during the Chindit expedition of World War II, reported that the loss of the ability to communicate had the undesired effect wherein the devoiced mule had to 'see before he would go as opposed to talk before he went'. This concept was exemplified during a river crossing of the Irrawaddy River, whereby the devoiced mules would turn their heads back and see the other mules on-shore, at which point they would attempt to turn backwards.[4] Mules with a normal voice would cross a river by communicating with their fellows on the far bank.

Since the nineteenth century, various surgical techniques were developed with the aim of removing the mule's ability to bray. We review the techniques employed and examine their limitations.

Henry Henning's approach

Henry Henning, a veterinary surgeon of the New York State Veterinary College suggested two methods of stopping a mule from braying. The first operation involved removing two small muscles at the top of the tail, resulting in an inability to raise the tail. After noticing that a mule throws its tail up prior to braying, Henning suggested that if a mule could not raise its tail, it would be unable to bray. His second operation involved splitting the mule's 'false nostril'. The false nostril is a pocket of tissue extending several centimetres above the real nostril that magnifies the braying sound produced by the mule. By splitting the false nostril and making it part of the real nostril, the sound of the mule braying is dimmed but not eradicated.[5] The techniques employed by Henning were novel, but proved to have limited effectiveness and were not widely adopted.

Experience with 'roaring' in horses

Unlike 'braying' in mules, horses have an unrelated problem, known as 'roaring'. Roaring in horses is due to paralysis of the left recurrent laryngeal nerve (RLN). Unfortunately, selective breeding of horses for domestic purposes over the centuries has made left-sided RLN palsy a common pathology in modern horses. Left RLN paralysis causes collapse of the ipsilateral vocal fold and turbulent airflow, leading to a roaring sound during strenuous activity.[6]

Various techniques were developed to address roaring in horses, with reasonable success. As a result, the same techniques were initially used to address braying in mules. Techniques to address 'roaring' in horses are described below.

Arytenoidectomy

Gunther Sr and Gunther Jr of Hannover first attempted the arytenoidectomy approach in 1845. The aim was to improve airflow by excising the arytenoid cartilage, rather than stabilising or retracting it (Figure 1).[7,8] A ventral laryngotomy incision was made, splitting apart the cricoid and thyroid cartilages, and removing the entire arytenoid cartilage. Seton stitches were then placed in the laryngeal sac, with the aim of securing adhesions from the arytenoid site to surrounding structures.[9]

The Gunthers discovered that total arytenoidectomy resulted in a high incidence of post-operative dysphagia and resultant aspiration pneumonia. This was thought to be secondary to the loss of the arytenoid's ability to protect the airway and close the glottis during swallowing. The procedure also often caused excessive tissue granulation and progressive narrowing of the laryngeal aperture, which consequently led to airway obstruction.[7,9]

As a result, Gunther Jr attempted partial arytenoidectomy instead, with particular emphasis on leaving behind the corniculate cartilage. Unfortunately, it was then found that the remaining corniculate cartilage occasionally caused partial obstruction of the rima glottides.[10]

In 1888, Möller reported success with partial arytenoidectomy, claiming to have 'cured' 22 out of 30 horses.[8,11] His procedure was based on the Gunthers' approach, but included the insertion of a tampon tracheostomy tube to prevent aspiration. Fleming and Cadiot also reported success with variations to this approach.[11] However, this was disputed by Dollar, who claimed that many horses treated in this way experienced poor long-term outcomes secondary to chronic cough, airway narrowing and severe dyspnoea.[9]

Vocal cordectomy and ventriculectomy

Gunther Sr and Gunther Jr first performed a bilateral vocal cordectomy in 1845, with little success, as the horses continued to roar. This was followed by removal of the fold solely on the paralysed side. The roaring, however, was only aggravated, as removal of the fold caused the arytenoid to become more malleable and was consequently dragged further into the larynx by cicatricial contractions. Gunther Jr then attempted unilateral removal of the ventricle and vocal fold on the paralysed side, but surprisingly did not encounter favourable results.

Gunther Jr first described a variant of ventriculectomy in 1866. He aimed at forming a fibrous tissue connection between the arytenoid cartilage, vocal folds and thyroid cartilage by removing the ventricle. In some cases, the arytenoid became united to the thyroid in a sufficiently high position, and a cure was effected. In other cases, the union was incomplete and too low, with horses remaining as 'roarers'.

The technique underwent various minor modifications by others over the following years. These modifications included: suturing the opening of the ventricle, cauterisation of the ventricle, removing the vocal fold and different methods of stripping the ventricular mucosa (Figure 2).[7]

In 1907, WL Williams, a veterinary surgeon from New York, described a modern and simplified version of ventriculectomy, prior to its popularisation by Sir Frederick

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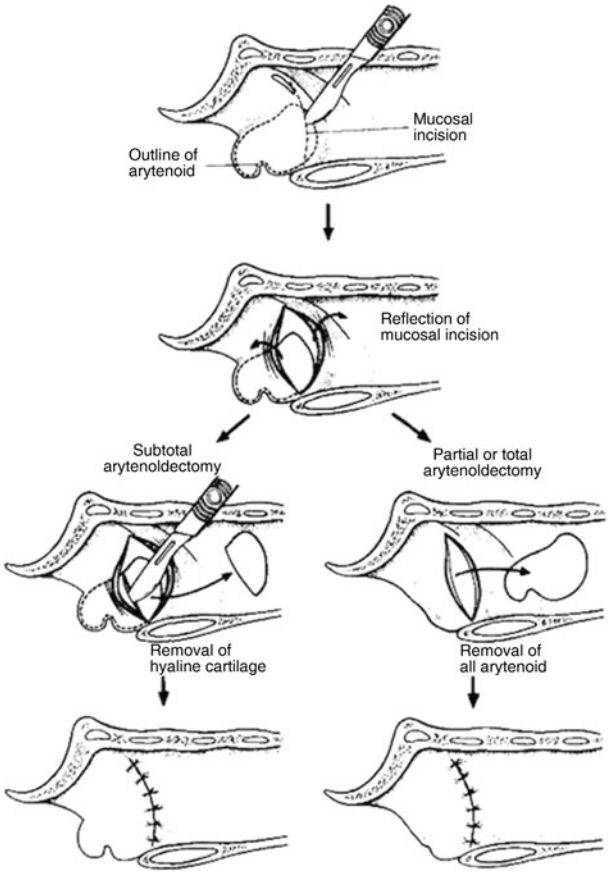

Fig. 1. Arytenoidectomy procedure. Reproduced with permission from Wiley Publications.[7]

Hobday in 1910. Hobday's procedure involved stripping the mucous membrane lining of the lateral ventricle in order to generate a fibrous adhesion between the vocal fold and thyroid cartilage, thereby lateralising the fold and opening the airway.[12] The incision took approximately three to four weeks to heal with regular wound cleaning, while the horse took approximately three weeks to fully recover.

Hobday introduced two innovations that revolutionised the technique. Firstly, he stripped the mucous membranes of both ventricles instead of the solitary affected one. This widened the larynx to its maximal dimensions, as each fold adhered to the interior of the larynx.[13] Secondly, he made an incision through the cricothyroid membrane, instead of splitting the thyroid cartilage. This significantly improved morbidity.

Use of roaring procedures for horses to stop braying in mules

Initial attempts to stop braying in mules involved modifying techniques used to treat roaring in horses.

Arytenoidectomy and vocal cordectomy was attempted. Brigadier Stewart, Veterinary Surgeon of the British Armed Forces in World War II, chose to initially perform a partial cordectomy (elliptical or triangular incision). He found that there was little change to respiration, but also little diminution to the braying of the mules.[14]

Adapting Hobday's procedure to prevent braying in mules was difficult. As the ventricle of the mule differs in its shape to that of a horse and is more deep, the process of stripping the mucosa proved to be challenging in the mule, requiring more than two incisions for separation from the larynx.[4,14] In addition, the ventricular opening in mules is encroached by the islets of the cartilage to a greater degree.[15] The wound typically took three weeks to heal by granulation. Given the tight timeframes required for military purposes, the technique did not achieve widespread use.

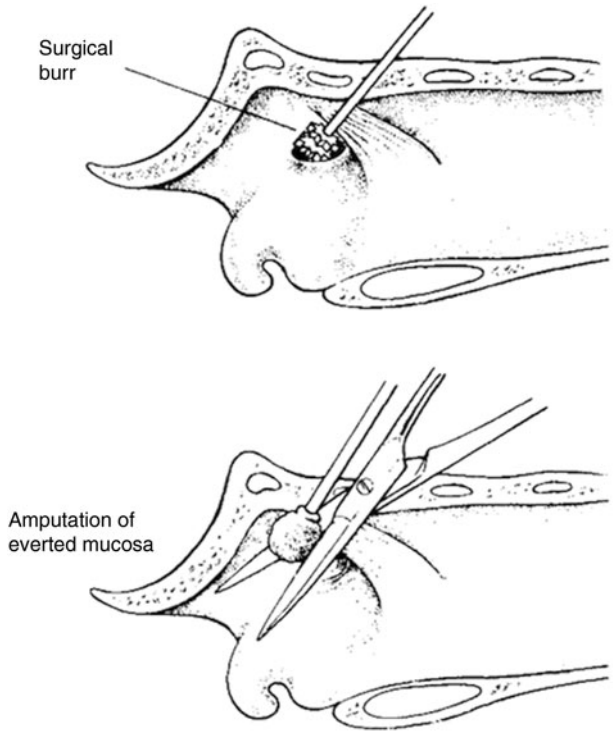

Fig. 2. Ventricular mucosa excision. Reproduced with permission from Wiley Publications.[7]

Chindit expedition

In December 1941, the Japanese declared war against the USA and Britain. They struck swiftly, attacking targets such as Pearl Harbour, Hong Kong, Malaya and Burma.

Colonel Orde Wingate, a veteran of guerrilla warfare in Palestine and Abyssinia, was appointed to command operations in Burma following the Japanese invasion in January 1942. Wingate developed a tactical technique called 'long-range penetration', which involved dropping Special Forces soldiers behind enemy lines by long-range aircraft, and organising them into columns such that they could inflict heavy blows but evade capture if under attack. Known as the 'Chindits' (a mythical Burmese beast that guards Buddhist temples), they included British and Indian soldiers, Burma Rifles, Hong Kong Volunteers, Gurkhas and West African Serviceman (Figure 3).[16]

There were two Chindit expeditions into Burma. Operation Longcloth in February 1943 comprised 3000 men, with over 1000 miles trekked during the campaign. Operation Thursday followed this in March 1944, with a force of 20 000 British and Commonwealth troops, with additional support from the US Air Force, making it the biggest airborne invasion during World War II. The Chindits suffered high casualties, with many wounded, killed or taken prisoner. The mission was successful, with the eventual surrender of the Japanese. Tragically, within a few weeks of the commencement of Operation Thursday, General Wingate was killed.

The brigade had to prepare for both the strenuous jungle terrain and the Japanese army. Mules were important to the

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Fig. 3. Chindit column crossing a river in Burma. Reproduced with permission from Imperial War Museum (UK).[16]

Chindit campaign as they carried ammunition, weapons and medical supplies.[17]

During the first expedition, it became evident that the mules used for transport would bray, which alerted the enemy to the oncoming Chindits. As this was a matter of urgency, an effective solution capable of treating large numbers of animals was required. In addition, the results needed to be permanent and not impact on the ability of the mule to work.

In June 1943, Brigadier Lentaigne, who was raising troops for the second Chindit expedition approached Brigadier Stewart, Veterinary Surgeon of the British Armed Forces in World War II, for a solution.

During Stewart's work as a veterinary surgeon in India, he had operated on a large number of horses for roaring. He found that the techniques used (arytenoidectomy and Hobday's procedure) had been effective for roaring, but did not completely devoice the animals. As a result, Stewart chose to approach Major Moffett (later Lieutenant-Colonel) for his expertise and assistance as a laryngologist.[4]

Arthur James Moffett

Arthur James Moffett was a British otolaryngologist, most recognised for his eponymous solution for nasal anaesthesia, which remains in extensive use today.[18] His contributions to otolaryngology extend across many domains, including the field of warfare. Born in 1904, in Galway, Ireland, Moffett spent his early childhood in Bromsgrove, England. He received his medical education in Birmingham, where he went on to work as a consultant ENT surgeon. In 1939, he joined the Royal Army Medical Corps, where he was posted to India and Burma during World War II.[19]

Moffett's technique

Moffett's experience in excising vocal fold malignancies in humans led him to conclude that in mules, if the muscles that underlie the vocal fold are not severed or preferably partially removed, then continuous action would cause partial regeneration of the fold, which could be sufficient to give rise to voice. As such, there needed to be complete excision of the fold and underlying muscle.[14]

After being approached to devise a solution, Moffett began by experimenting on preserved mule laryngeal specimens. He found the Hobday procedure somewhat cumbersome, and instead preferred a direct approach of excising both vocal folds and underlying musculature. He subsequently informed Stewart of his findings in a technical memo.

Stewart then experimented on approximately 50 out-of-service mules and found no evidence to suggest development of any potential complications. Moffett was then invited to a remount depot; he and Stewart tested both techniques in anaesthetised mules, and found the excisional procedure far simpler with a faster recovery for the mules.

Moffett and Stewart's technique was subsequently refined for wide-scale usage. Captain RN Phillips gave an account of the process in 1959.[15] It involved a crico-thyroidean incision to gain access to the larynx. The vocal fold was lifted with straight forceps, with an incision made on the outer surface of the fold. Using a scalpel, the muscles were then separated from the side of the larynx, and straight forceps were used again to hold the fold and excise the muscle. An incision was then made across the fold outwards and backwards, such that the rear of the first incision was met. With a firm hold, the attachment of the inner reflection of the fold to the thyroid cartilage was cut. The muscle and fold were freed from any underlying anterior or lateral attachments, with care taken to avoid damage to the small cartilaginous process. The arytenoids (now devoid of fold) were seen rhythmically moving upon inspiration with the remainder of the muscle out.[15]

A wide-scale devoicing campaign began on the 111th Brigade mules under treacherous monsoonal conditions. Mules had their legs tied by expert handlers and were placed supine upon the jungle floor over a bed of grass, with tarpaulin shelters shielding them from the rain. Chloral hydrate and chloroform anaesthesia were used at varying periods of the campaign depending on the need for speed. Chloral hydrate did not stimulate respiration or increase blood pressure, facilitated normal movement of the folds, reduced intra-operative bleeding and promoted a faster operation. It however, caused some cases of delayed action phlebitis. The operation was conducted from the left side of the mule in a seated position, allowing for the right vocal fold to be operated on without needing to change sides. During the latter stages of the project, operations were conducted under local anaesthetic and cocaine solution, with the mule being operated on in a standing position.

With the new operation, there were a number of problems encountered. Firstly, there was the issue of wound infections in non-sterile environments, and exposure to flies and maggots. Wounds were dressed with iodoform and anti-fly ointment was applied, with regular wound checks performed. Secondly, there was the issue of recovery of voice. General Wingate had noticed that a small proportion of mules had a return of voice within a matter of days following healing of the neck wound. This occurred because of the failure to carry the first incision within the larynx far enough back, resulting in a forwards instead of the correct backwards cut from the vocal process with the end of the first incision. The resulting partial cordectomy gave rise to a return of voice.

The operation proved to be an overall success, with a recovery time of approximately 10 days and a low casualty rate of 0.77 per cent (43 deaths from 5563 operations), the majority of which occurred during earlier operations where phlebitis was a problem. Apart from the obvious tactical benefits of the devoiced mules not alerting the enemy of the approaching Chindit troops, the mules would be trained to be fed to a whistle without the usual outburst of brays. This was employed

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during river crossings, where the mules would swiftly move in the direction of the whistle in anticipation of food.

Eventual abandonment

Mules filled an important niche role within the Allied forces. They proved to be useful in areas with poor terrain, where access for mechanical transport was difficult. Soldiers continued to have a great affection for them. However, as the era of mechanical warfare continued to impose itself, the mules and their accomplishments were eclipsed. On 15 February 1957, the US Army officially disengaged the last two mule units in Fort Carson, Colorado. Despite this discontinuation, they have still been intermittently used, as evident during the 1980s, when the Central Intelligence Agency purchased mules to support the Afghans against the Soviet occupation of Afghanistan.[20]

Conclusion

Examining how different techniques have evolved in attempting to correct 'roaring' or 'braying' in equine species reveals a fascinating story of innovation in laryngology that had a considerable impact on world history. By drawing upon techniques such as arytenoidectomy, ventriculectomy and vocal cordectomy, used for treating 'roaring' in horses, Moffett and Stewart developed a procedure that provided a quick, reliable and safe solution to silence the braying of mules in the Chindit expedition, saving the lives of troops and their animals alike.

Competing interests. None declared

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