The Journal of Laryngology & Otology

cambridge.org/jlo

Evaluating nasal cautery techniques in epistaxis

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Abstract

Background. Silver nitrate cautery and bipolar electrocautery are commonly used in the treatment of epistaxis. Currently, there are no recommendations on optimum contact times or power for nasal cautery. ENT consultant practice in the UK has not previously been evaluated.
Methods. This study examined the burn depth associated with silver nitrate (75 per cent concentration) cautery and bipolar electrocautery on porcine septum samples, using varying contact times and power. ENT consultants completed a survey evaluating their practice.
Results and conclusion. ENT consultant practice of nasal cautery was shown to vary widely. Silver nitrate cautery with a contact time of less than 30 seconds does not cause a full thickness burn. The findings lend some support to bilateral cauterisation with silver nitrate. Bipolar electrocautery should be set at lower than 10 W and with a contact time of less than 4 seconds to reduce the risk of complications associated with a full thickness burn.

Main Article

Mr J Bastianpillai takes responsibility for the integrity of the content of the paper

Presented at the Royal Society of Medicine Laryngology and Rhinology Section Meeting, 3 February 2017, London, UK.

Cite this article: Bastianpillai J, Saxby C, Coyle P, Armstrong A, Mohamid W, Mochloulis G. Evaluating nasal cautery techniques in epistaxis. *J Laryngol Otol* 2019;**133**:923–927. https://doi.org/10.1017/S0022215119002056

Accepted: 18 August 2019
First published online: 7 October 2019

Key words:
Epistaxis; Cautery; Cauterization; Silver Nitrate; Electrocautery

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Introduction

Epistaxis is one of the most common presentations to the ENT specialist. A reported 60 per cent of the population experience an epistaxis episode in their lifetime, and 6 per cent seek medical attention.[1]

The arterial supply to the nose originates from branches of the internal and external carotid arteries, and forms a rich anastomosis known as Kiesselbach's plexus on the anterior aspect of the nasal septum. Bleeding originating from this region accounts for approximately 80 per cent of epistaxis episodes.[2] Posterior bleeding originates from Woodruff's plexus on the posterior septum, and is mostly supplied by the posterior septal nasal artery (a branch of the sphenopalatine artery). Typically, the latter can be associated with greater morbidity.[3]

The aetiology of epistaxis is diverse (Table 1) and mostly idiopathic (80–90 per cent);[2] however, trauma is a common precipitant, especially as the blood vessels are relatively superficial within the mucosa. Recurrent or persistent epistaxis can less commonly be caused by bleeding disorders or neoplasia and warrant further investigation.

Managing epistaxis requires a stepwise approach, starting initially with first aid and resuscitation, and then identification of a bleeding point with subsequent cauterisation. If these attempts fail, the patient can proceed to nasal packing, and finally to surgical intervention such as arterial ligation or embolisation.[2]

Nasal cautery can be performed chemically with silver nitrate ($AgNO_3$)-tipped caustic pencils, which are commercially available in two concentrations (75 per cent and 95 per cent).[4] The silver nitrate is fused with potassium nitrate on the tip of a wooden pencil and, when directly applied to visible vessels on the septum, the resulting chemical reaction replaces healthy mucosa with scar tissue, and thromboses blood vessels within it.[5] The affected area of tissue is burned, and can be graded as a superficial partial thickness burn (loss of surface epithelium with no mucosal necrosis), a deep partial thickness burn (partial mucosal necrosis) or a full thickness burn (full thickness necrosis reaching the perichondrium), depending on the extent of penetration of the chemical wave front produced. Superficial bleeding vessels are contained within the mucosa; therefore, a deep partial thickness should be sufficient for effective cautery.

The effect of silver nitrate concentration on clinical outcomes in epistaxis has not been fully established, but the 95 per cent preparation is associated with greater tissue penetration and therefore possible complications.[5] Application of silver nitrate cautery can be painful; therefore, topical anaesthetic is preferable. However, this can make the use of silver nitrate cautery in children challenging. Nevertheless, it is a relatively inexpensive technique that requires minimal technical skill. This makes it popular amongst ENT specialists, and in general practice and emergency departments when available.

An alternative method is bipolar electrocautery, where an electrical circuit delivers thermal energy by radiation to the area, rather than by direct contact.[2] The resultant burn seals the blood vessel much in the same way as chemical cautery. Ahmed and

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Table 1. Causes of epistaxis*

Local
– Idiopathic
– Trauma – nose picking, fracture, foreign body
– Inflammation – infection, nasal polyps, rhinitis
– Neoplasia – malignant, benign
– Vascular – e.g. granulomatosis polyangiitis, HHT
– Iatrogenic – surgery, instrumentation
– Structural – septal perforation
– Drugs – cocaine, topical decongestants
General
– Haematological – coagulopathies, platelet dysfunction, thrombocytopaenia
– Environment – altitude, temperature, humidity
– Drugs – anticoagulants, anti-platelets
– Organ failure – renal failure, liver failure
– Systemic – hypertension, alcohol

*Adapted from Pope and Hobbs.[2] HHT = hereditary haemorrhagic telangiectasia

Woolford have shown that in suitably trained hands, the use of bipolar diathermy and rigid endoscopy can significantly reduce the morbidity associated with subsequent nasal packing and avoid the requirement for hospital admission.[6]

Traditional teaching dictates that bilateral cauterisation of the septum should be avoided given the potential risk of a septal perforation. However, clinical studies have lent support to bilateral cauterisation without the risk of septal perforation, albeit in small sample sizes and with a short follow-up period.[7] In addition, there have been no published studies on the incidence of septal perforation after cautery.

When utilising chemical cautery or electrocautery, the optimum contact time or power for a fully intact septum has not previously been determined. We examined the microscopic effects of different contact times and powers on intact porcine septum samples, to establish the optimum conditions required for cautery.

As there are no recommendations for the optimum conditions for cautery, we also evaluated current practice amongst ENT consultants in the UK to determine patterns in management.

Materials and methods

Histological assessment of cautery

A prospective, single-blinded, *ex vivo* study was conducted. Porcine septum samples were selected, and chemical cautery was applied using 75 per cent silver nitrate tipped caustic pencils (Bray Health and Leisure, Faringdon, UK) with varying contact times (5 seconds, 10 seconds, 20 seconds and 30 seconds). This application was repeated in three different places of the septum, but only unilaterally. The septum was then placed in formalin and sent to a veterinary laboratory to be prepared in paraffin, and stained with haematoxylin and eosin. Each treated area was labelled with a unique code corresponding to the parameter tested. A consultant histopathologist, who was blinded to the codes, examined the septum under light microscopy and graded each chemical burn as being of superficial partial thickness, deep partial thickness or full thickness.

Table 2. Questions used in online survey of consultant practice

Question	Response options
1. Do you use local anaesthetic prior to performing nasal cautery?	Yes/ No
2. Are you aware of the different strengths of silver nitrate tipped caustic pencils?	Yes/ No
3. What strength silver nitrate tipped caustic pencil do you use?	75%/ 95%/ Don't know
4. You apply cautery to the septum for…	A set amount of time/ A variable amount of time
5. How long do you apply the silver nitrate tipped caustic pencil for?	5 sec/ 10 sec/ 20 sec/ 30 sec/ Other (please specify)
6. How long do you apply the bipolar forceps to the septum for?	2 sec/ 4 sec/ 6 sec/ Not used
7. What power do you set the bipolar at for nasal cautery?	4W/ 6W/ 8W/ 10W/ 12W/ Not used
8. Would you cauterise both sides of the septum at the same time if you noted bilateral friable vessels?	Yes/ No
9. Does your ENT treatment room have bipolar available for nasal cauterisation?	Yes/ No/ Don't know

Sec = seconds

Table 3. Histological effects of silver nitrate at variable contact times

Contact time	First application*	Second application*	Third application*
5 sec	SPT	SPT	SPT
10 sec	SPT	DPT	DPT
20 sec	DPT	DPT	DPT
30 sec	DPT	DPT	DPT

*Of silver nitrate cautery. Sec = seconds; SPT = superficial partial thickness; DPT = deep partial thickness

This process was repeated using bipolar diathermy at different powers (6 W, 8 W and 10 W) and using each power at different contact times (2 seconds, 4 seconds and 6 seconds), with each combination repeated three times.

Assessment of consultant practice

A nine-question online survey evaluating different aspects of nasal cautery practice (Table 2) was emailed to all consultant ENT surgeons in the UK who were registered with ENT-UK, the UK professional membership body for ENT and its related specialties. The survey was open for one month during July 2016. The results were collated online and statistical analysis was performed using Microsoft™ Excel spreadsheet software.

Results

Histological effects of cautery

For silver nitrate cautery (Table 3), application for 5 seconds produced superficial partial thickness burns when repeated three times. When applied for 10 seconds, there was one superficial partial thickness burn and two deep partial thickness burns. At 20 seconds and 30 seconds, all applications produced deep partial thickness burns. There were no full thickness burns.

https://doi.org/10.1017/S0022215119002056 Published online by Cambridge University Press

Table 4. Histological effects of bipolar diathermy at variable contact times

Contact time	Applications* at 6 W			Applications* at 8 W			Applications* at 10 W		
	First	Second	Third	First	Second	Third	First	Second	Third
2 sec	SPT	SPT	DPT	SPT	SPT	SPT	FT	FT	FT
4 sec	DPT	DPT	DPT	DPT	DPT	DPT	FT	FT	DPT
6 sec	DPT	DPT	FT	FT	DPT	FT	FT	FT	FT

*Of bipolar diathermy. Sec = seconds; SPT = superficial partial thickness; DPT = deep partial thickness; FT = full thickness

Table 5. Contact times used for silver nitrate cautery in consultant practice

Contact time	Respondents (*n* (%))
5 sec	56 (29.2)
10 sec	43 (22.4)
20 sec	16 (8.30)
30 sec	11 (5.70)
Other	66 (34.4)

Sec = seconds

Table 6. Contact times and power used for bipolar electrocautery in consultant practice

Parameter	Respondents (*n* (%))
Contact time	
– 2 sec	78 (75.0)
– 4 sec	24 (23.1)
– 6 sec	2 (1.92)
Power	
– 4 W	9 (8.04)
– 6 W	26 (23.2)
– 8 W	28 (25.0)
– 10 W	38 (33.9)
– 12 W	11 (9.82)

Sec = seconds

For bipolar diathermy (Table 4), at 6 W two of the applications produced superficial partial thickness burns (both 2 seconds) and one gave a full thickness burn (6 seconds). The other six applications gave a deep partial thickness burn. At 8 W, all three samples had superficial partial thickness burns at 2 seconds, all three samples had deep partial thickness burns at 4 seconds and two samples had full thickness burns at 6 seconds. One of the samples at 6 seconds had a deep partial thickness burn. At 10 W, eight out of nine tests produced a full thickness burn, with one deep partial thickness burn at 4 seconds.

Consultant practices

Of the 742 surveys emailed out, 193 surveys were returned (26.0 per cent response rate). The surveys revealed that local anaesthetic is used (prior to cautery) by 92.7 per cent of the ENT surgeons who responded ($n = 179$).

Regarding silver nitrate cautery, 49.5 per cent ($n = 95$) of respondents are aware that different concentrations exist; 43.0 per cent ($n = 83$) use 75 per cent concentration, 8.8 per cent ($n = 17$) use 95 per cent concentration and 48.2 per cent ($n = 93$) do not know what concentration they use. Silver nitrate is applied for a fixed time by 22.9 per cent of respondents ($n = 44$) and for a variable amount of time by 77.1 per cent ($n = 148$). The contact times reported were: 5 seconds (29.2 per cent; $n = 56$), 10 seconds (22.4 per cent; $n = 43$), 20 seconds (8.3 per cent; $n = 16$), 30 seconds (5.7 per cent; $n = 11$) or 'other' (34.4 per cent; $n = 66$) (Table 5). The most common responses for the 66 'other' reported contact durations were: 'until desired effect achieved' ($n = 17$), 'variable' ($n = 16$) and 'less than 5 seconds' ($n = 13$).

Regarding bipolar electrocautery, 42.0 per cent of respondents (78 out of 182) do not routinely use it for epistaxis. For the remaining 104 consultants, the reported durations of use were: 2 seconds (75 per cent; $n = 78$), 4 seconds (23.1 per cent; $n = 24$) and 6 seconds (1.92 per cent; $n = 2$). The powers used are 4 W (8.04 per cent), 6 W (23.2 per cent), 8 W (25.0 per cent), 10 W (33.9 per cent) and 12 W (9.82 per cent) (Table 6). Bipolar electrocautery is accessible in 25.4 per cent of ENT treatment rooms ($n = 49$) and is unavailable in 70.5 per cent ($n = 136$); availability is unknown in 4.1 per cent ($n = 8$).

A reported 40.1 per cent of consultants ($n = 75$) would cauterise the septum bilaterally if vessels were visible.

Discussion

Our results showed that, with silver nitrate cautery, there was no full thickness burn with an application time of up to 30 seconds, and there was little difference in penetration after 5 seconds. With bipolar electrocautery, there were no full thickness burns at 8 W or below with contact for 4 seconds or less. At 6 seconds at any power, or at 10 W for any contact time, there was a high risk of a full thickness burn (67 per cent and 89 per cent respectively).

There have been few studies demonstrating the histological effects of silver nitrate or bipolar diathermy on septal tissue. Lloyd *et al.* investigated the effect of 75 per cent silver nitrate on human septal cartilage, albeit denuded of mucosa, for application times of 30–60 seconds. They reported no significant difference in penetration depth between 30 and 60 seconds.[8] Our study used septa covered in mucosa, which is more representative of clinical practice, given that this is where most target vessels lie, and tested shorter contact times. Hanif *et al* investigated the effect of silver nitrate on tonsil tissue. They found that, histologically, there was no difference in penetration depth between 5 and 20 seconds when using 75 per cent concentration.[9] This is encouragingly in accordance with our own results, which tested up to 30 seconds and revealed similar findings.

https://doi.org/10.1017/S0022215119002056 Published online by Cambridge University Press

Studies have been conducted on tonsillar tissue that demonstrated the differences in penetration between 75 and 95 per cent concentration. For instance, in Amin and colleagues' study, 95 per cent concentration yielded a two-fold greater penetration depth when applied for 5 seconds, possibly conferring a higher risk of complications, without necessarily providing greater efficacy.[5] Glynn *et al.* similarly showed that, in paediatric patients, 75 per cent concentration had better pain and efficacy outcomes after an eight-week follow up compared to 95 per cent concentration.[10] Based on this work of Glynn *et al.* and Amin *et al.*, we chose the 75 per cent concentration for our study. We could therefore conclude that there is no benefit of 75 per cent silver nitrate cautery beyond 5–10 seconds on histological outcome, though it can safely be used for up to 30 seconds.

There have been no clear *ex vivo* studies demonstrating the use of bipolar diathermy on the nasal septum. However, Johnson *et al.* described its application in clinical practice at 15–20 W (contact time not reported) and did not report any long-term complications up to a mean follow-up period of 428 days.[11] Our study showed that a considerably lower power (10 W) could cause a full thickness burn, which can potentially cause complications of crusting and septal perforation.

It is thought that septal perforation occurs as a result of disruption to the overlying perichondrium and perichondrial blood supply, which leads to necrosis and subsequent perforation. For adequate treatment of epistaxis, the blood vessels that lie within the mucosa need cauterisation, suggesting that a deep partial thickness burn is sufficient, whereas a full thickness burn results in cauterisation of the perichondrium. Felek *et al.* tested bilateral chemical cautery at 75 per cent concentration in children, with no septal perforation; however, they applied it for only 5 seconds.[12] Our study showed that this contact time resulted in a superficial partial thickness burn which did not disrupt the perichondrium. This lends some support to safe bilateral cauterisation. Performing bilateral cauterisation could reduce the number of hospital appointments and potentially avoid the need for multiple general anaesthetic procedures in the paediatric population.

The survey results revealed that half of the consultants were not aware of the different silver nitrate concentrations; indeed, nearly half are not certain which strength they use in practice. This could have practical implications, as 95 per cent silver nitrate has been proven to be more penetrating[5] and confers a greater risk to perichondrial disruption, especially as 40.1 per cent of respondents would cauterise bilaterally.

The length of contact time in practice is variable, with 77.1 per cent of responding consultants not using a fixed method. However, our results demonstrate that at least 5–10 seconds are needed for sufficient burn penetration. Although this was the practice amongst most consultants, a substantial portion still applied silver nitrate for less than 5 seconds, or used macroscopic or clinical signs to determine how long to apply it, which could have implications for symptom recurrence if undertreated. It should also be noted that the interpretation of contact time by each consultant is likely to be variable, which limits the reliability of the conclusions drawn.

Bipolar electrocautery is not commonly used across the UK in the out-patient setting, with many ENT departments not having the equipment available in the clinic setting. Bipolar electrocautery is less forgiving than chemical cautery and technically more difficult to apply, as well as being costlier to provide.[6] A third of consultants do not use bipolar electrocautery.

There was variability reported in the power settings used for bipolar electrocautery. Interestingly, 43.8 per cent of respondents admitted to setting the bipolar electrocautery power to 10 W or more; at this setting, full thickness burns were reliably produced in our study. Although the risk of complications in real terms is theoretical given the paucity of clinical data, there is an argument to support using power of 8 W or less given our data. The contact time used is more consistent, with 42.9 per cent of respondents applying bipolar electrocautery for 2 seconds, which may negate some of the risk involved. The variability in practice is likely to reflect the lack of a definite guideline or supportive studies.

- Epistaxis is a common complaint; the use of silver nitrate and bipolar diathermy for cauterisation are widespread
- Silver nitrate (75 per cent concentration) can be used up to 30 seconds without a full thickness burn, but only 5–10 seconds are needed for adequate histological effect
- Bipolar diathermy should not be used for more than 4 seconds or at more than 8 W, to avoid full thickness burn and potential complications
- Consultant practice across the UK is variable in the absence of established recommendations
- Our recommended parameters can inform further clinical studies and subsequent clinical practice

There are issues in applying our study findings to clinical practice. Our study is limited by being an *ex vivo* study conducted on porcine tissue and, furthermore, small sample sizes were used. It does, however, provide some insight into the contact times which could be used effectively and, in particular, the power that bipolar diathermy should not exceed. Similarly, the response rate of the survey was only 26.0 per cent; therefore, caution should be exercised when extrapolating the practice of all UK ENT consultants. Further studies should investigate the long-term effects of applying cautery at our recommended times and power settings, or using different concentrations, in clinical practice, and establish the efficacy on arresting epistaxis. In particular, it would be interesting to determine the rate of septal perforation in these patients.

Conclusion

Our study showed that the ENT consultant practice of nasal cautery varies widely. We have shown that silver nitrate (75 per cent concentration) cautery, with a contact time of 30 seconds or less, does not cause a full thickness burn. Furthermore, our findings lend some support to bilateral cauterisation with silver nitrate. Bipolar electrocautery should be performed at less than 10 W and with a contact time of less than 4 seconds, to reduce the risk of complications caused by a full thickness burn.

Competing interests. None declared

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https://doi.org/10.1017/S0022215119002056 Published online by Cambridge University Press