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Histological changes in the nasal mucosa after hot-water irrigation. An animal experimental study*

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SUMMARY

Many years ago the treatment of posterior epistaxis was irrigation with hot water through the bleeding nose cavity, and the treatment was successful in many cases. The aim of this study is to explain how "hot-water irrigation" can cause haemostasis. Twenty-four rabbits were divided into 12 groups and their noses were irrigated for 5 min with hot water at temperatures ranging from 40-60°C. After irrigation, the nose was fixed, sliced, stained, and evaluated blindly by a pathologist. The morphological changes - narrowing of intranasal lumen, vasodilation and stasis, extravasation of erythrocytes, and epithelial necrosis - were recorded. No changes were recorded after irrigation with water of 40–44°C. Only light changes were present in the 46°C group. Vasodilation occurred at a temperature of 48°C or higher. From 48°C, oedema of the mucosa and subsequent narrowing of the intranasal lumen was seen. Severe changes including epithelial necrosis, were found only in the groups treated with 52°C or higher. The results of the study indicate that the haemostatic effect of hot water treatment for epistaxis may be caused by: (1) oedema and narrowing of the intranasal lumen, (2) vasodilation of the mucosal vessels, and (3) cleaning of the nose from blood coagulates.

Key words: hot-water irrigation, mucosal changes

INTRODUCTION

Posterior epistaxis is difficult to treat and the condition usually demands hospitalization for several days. The usual treatment is tamponade of the bleeding nose cavity with gauze or water-filled balloons. Both treatments are effective but unpleasant and painful for the patients. An alternative for treating posterior epistaxis is hot-water irrigation (HWI) with water of 48–50°C through the bleeding nose cavity. HWI was first described by Guice and Fayette (1884), and became the routine treatment of epistaxis for many years (Bloch, 1907). However, during the last 30 years this procedure has been used only sporadically. Recently, a study was performed comparing HWI with tamponade treatment. In the HWI group, patients had less pain and the stay time in hospital were shorter compared to the tamponade group (Stangerup et al., 1995).

The aim of the present study was to describe the morphological changes after HWI in order to explain the underlying mechanisms, and to determine the optimal temperature of the water to be used for HWI.

MATERIAL AND METHODS

The study was designed as an animal experimental study using rabbits. The aim of the first phase of the study was to solve the practical problems of HWI of the rabbit nose, temperature span, form of anaesthesia, intubation, and how to irrigate with a well-defined flow, calibrated on the varying resistance in the nose of the individual rabbit. In the second phase of the study, the irrigated noses were evaluated in blind studies. Twenty-six albino rabbits were used; 14 for the first, and 12 for the second phase. After the rabbits had been anaesthetized with intravenous Mebumal and blind intra-oral intubation, they were placed on the side for irrigation, with the rear body in an elevated position to avoid aspiration of water. In the first phase of the study, two rabbits were treated with water at temperatures of: 40, 44, 48, 52, 55, 56, and 60°C. In the second phase of the study, two rabbits were irrigated with hot water of varying temperature: 44, 46, 48, 50, 52, and 54°C, respectively. The temperature and the side of the nose to be irrigated were decided by randomization. The irrigation was continued for 5 min. After an additional 5 min the

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rabbits were killed. The noses were fixed *in toto* in 10% phosphate-buffered formalin for at least one week, after which they were cut into 3-mm thick slices in a frontal plane. The larger slices from the posterior part of the nose were divided into a left and a right part. The slices were further fixed in the same fixative for some days before dehydration in ethanol and xylene, and embedding in Paraplast® at 56–60°C. Sections (5 μm) were stained with haematoxylin and eosin, and the slices were evaluated by one of us (HKT). In the initial experiments the different morphological features were recorded, while in the subsequent blind studies these changes (narrowing of intranasal lumen, vasodilation and stasis, extravasation of erythrocytes, and epithelial necrosis) were registered semiquantitatively (0: not present; 1: doubtful; and 2–4: present in increasing grades of severity). The parameters of the anterior part of the nose, the middle part of the nose, the posterior part of the nose as well as the contralateral side were recorded separately. However, when the different groups of animals were compared, the scores of all regions in the experimental side of both animals were added.

RESULTS

In the cross-sections the complex structure of the rabbit nose was seen (Figures 1–2). In the initial studies, no changes were recorded after irrigation with water of 40 or 44°C (Figure 3). Thus, the mucosal lining of the nasal cavity was preserved, there was no narrowing of lumen, the vessels were preserved, some patent others collapsed, and extravasation of erythrocytes was not observed. Both the squamous epithelium in the most anterior part of the nose and the pseudostratified columnar epithelium in the respiratory portions of the cavity appeared to be unaffected. After irrigation with water of 56°C, the lumen of the nasal cavity was considerably diminished (Figures 1 and 4). The blood vessels of the mucosal membrane were patent and dilated, and filled with erythrocytes (Figure 5). A large number of erythrocytes were present in the stroma (Figure 6). The cells of the columnar epithelium showed disintegration with fragmentation and clumping of the cytoplasm. The nuclei stained dark and were diminished. Often the epithelium had become separated from the connective tissue (Figure 7), and in some areas the epithelium was absent. The non-cornified squamous epithelium in the most anterior part of the nose also showed fragmentation with clumped cytoplasm and pyknotic nuclei.

The main results of the blind study are given in Tables 1–5, where the scores from the experimental side of the two animals in each temperature group have been added. It can be seen that no changes were present in the 44°C group, very slight changes

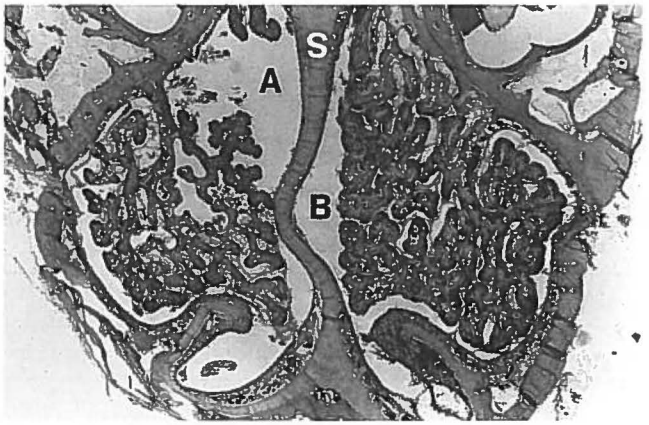

Figure 1. Low-magnification view showing the complex structure of the conchae system in the rabbit nose (×4; A: non-irrigated side with no narrowing of the intranasal lumen; B: irrigated side showing narrowing of the intranasal lumen; S: nasal septum).

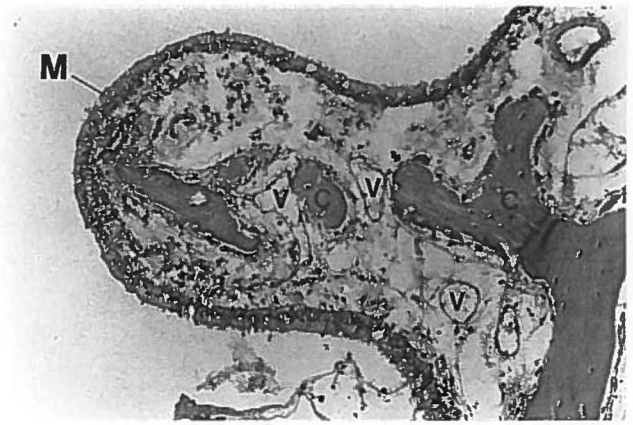

Figure 3. Detail of Figure 2 (×50). The mucosal lining (M) is preserved. Some vessels (V) are patent, but others have collapsed with only few erythrocytes remaining. Extravasation of erythrocytes is not seen (×50; C: conchae bone).

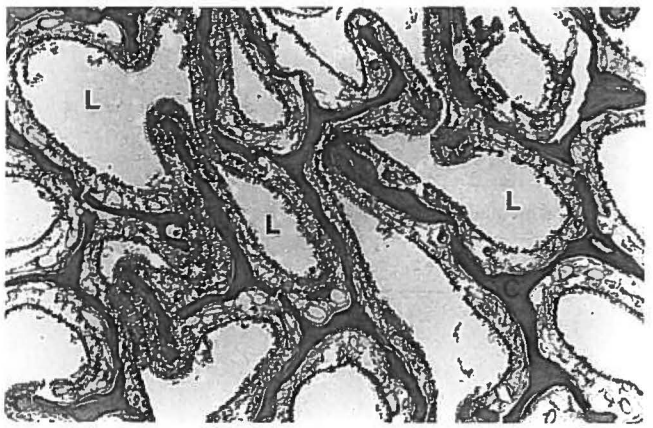

Figure 2. Part of the conchae system after irrigation with water of 44°C (×10; L: intranasal lumen; C: conchae bone).

Figure 4. Narrowing of intranasal lumen (L) after irrigation with water of 52°C (×10).

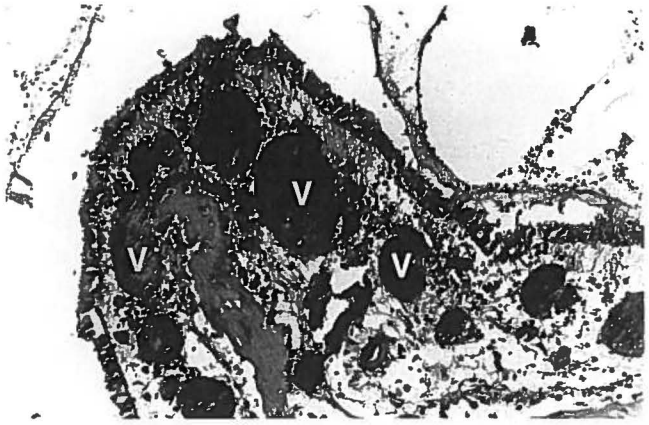

Figure 5. Vasodilation and stasis after irrigation with water of 48°C (×50; V: vessels).

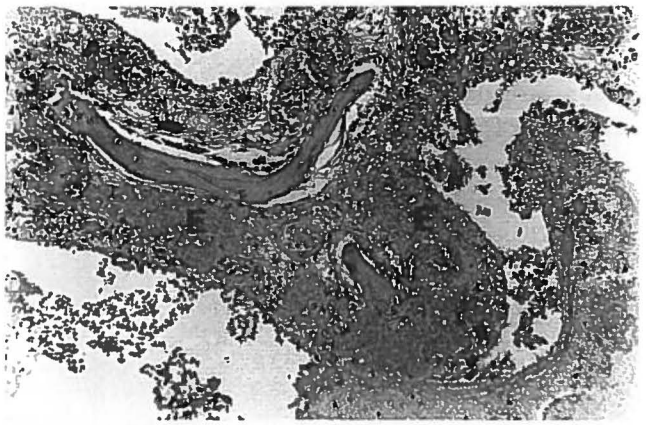

Figure 6. Extravasation of erythrocytes (E) after irrigation with water of 48°C (×50).

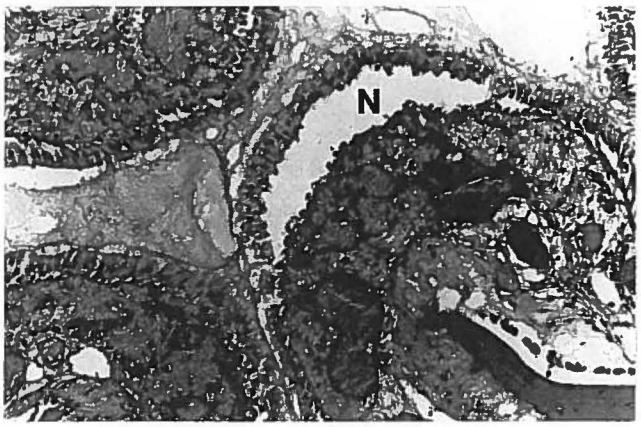

Figure 7. Epithelial necrosis (N) with loosening of the mucosal lining after irrigation with water of 54°C (×50).

were present in the 46°C group, and marked changes occurred in the 52°C and 54°C groups. In the 48°C and 50°C groups moderate changes were found, especially in the form of vasodilation and stasis. It should be noted that epithelial necrosis was not present in the 48°C and 50°C groups. In all affected animals, the changes were most marked in the anterior part of the nose closest to the source of irrigation, and minimal or absent in the posterior part of the nose. Slight vasodilation and stasis were found in the contralateral side of the nose in rabbits exposed to temperatures of 50°C or higher.

DISCUSSION

The findings in the present study, with no or only slight changes in the nasal mucosa after irrigation with water up to a temperature of 46°C, and marked changes, including epithelial necrosis, with water of 52°C to 56°C, are in accordance with previous experimental studies on skin (Moritz and Henriques, 1947; Thomsen, 1984) and with the clinical experience that the temperature range used in HWI in posterior epistaxis should be 48–50°C. Also, the morphology of the necrotic epithelial cells was identical to that described in skin experiments (Leach et al., 1943; Moritz and Henriques, 1947; Thomsen et al., 1983; Thomsen, 1984). However, in contrast to the skin, the nasal mucosa reacts to thermal exposure with marked vasodilation and oedema, also at temperatures that do not provoke tissue necrosis, probably because of the very loose texture of the connective tissue and the rich vascularization. The vascularization of the nasal mucosa, and consequently a high caloric uptake, may explain the gradient of decreasing mucosal changes as a function of increasing distance from the source of irrigation. In the human nose, the mucosal changes after HWI should be expected to be more homogenous through the nasal cavity since the resistance to irrigation in the rabbit nose is much higher than in the human nose because of a more complex structure of the conchae system.

Table 1. Narrowing of the intranasal lumen on the experimental side and the contralateral side after irrigation with water of 44–54°C. The scores of the two rabbits in each temperature group are added.

	experimental side			contralateral side		
°C	anterior	middle	posterior	anterior	middle	posterior
44						
46						
48	3					
50	2					
52	7	3		2		
54	8	5				

Table 2. Vasodilation and stasis on the experimental side and the contralateral side after irrigation with water of 44–54°C. The scores of the two rabbits in each temperature group are added.

	experimental side			contralateral side		
°C	anterior	middle	posterior	anterior	middle	posterior
44						
46	2	1			1	
48	5	4	2			
50	3	3		1	3	
52	8	6	2	5	4	1
54	8	6	3	4	4	3

Table 3. Extravasation of erythrocytes on the experimental side and the contralateral side after irrigation with water of 44–54°C. The scores of the two rabbits in each temperature group are added.

	experimental side			contralateral side		
°C	anterior	middle	posterior	anterior	middle	posterior
44						
46	2					
48	4					
50	4				2	
52	5	2				
54	4	4				

Table 4. Necrosis of the mucosal epithelium on the experimental side and the contralateral side after irrigation with water of 44–54°C. The scores of the two rabbits in each temperature group are added.

	experimental side			contralateral side		
°C	anterior	middle	posterior	anterior	middle	posterior
44						
46						
48						
50						
52	2					
54	1		1			

Table 5. Total score of all types of changes in the nasal mucosa on the experimental side and the contralateral side after irrigation with water of 44–54°C. The scores of the two rabbits in each temperature group are added.

	experimental side			contralateral side		
°C	anterior	middle	posterior	anterior	middle	posterior
44						
46	4	1			1	
48	12	4	2			
50	9	3		3	3	
52	22**	11	2	7	4	1
54	21*	16*	3	4	4	3

*: epithelial necrosis

CONCLUSION

Although the mechanisms of the haemostatic effect of the HWI cannot be established with certainty, it is tempting to suggest on the basis of the results of this study that: (1) oedema of the nasal mucosa, and subsequent narrowing of the intranasal lumen, causes internal and external tissue compression of the bleeding vessel; and (2) pronounced vasodilation decreases the intravascular blood-pressure and decreases the speed of the blood flow. Also, the cleansing of old blood and coagulates from the nose cavity caused by the irrigation may have an additional haemostatic effect. Based on old clinical experience we have focused only on the temperature range of 40-60°C in the present study. It is possible that irrigation with cold or even ice-water might have the same effect, and this will be the subject of a future study.

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