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Should we pay attention to the aberrant nerve communication between the lingual and mylohyoid nerves?

C. Zhan[a,1], Z. Yuan[b,1], R. Qu[c,1], L. Zou[b], S. He[c], Z. Li[c], C. Liu[c], Z. Xiao[c], J. Ouyang[c,*], J. Dai[c,*]

[a] *First School of Clinical Medicine, Southern Medical University, Guangzhou, China*
[b] *Second School of Clinical Medicine, Southern Medical University, Guangzhou, China*
[c] *Guangdong Provincial Key Laboratory of Medical Biomechanics, Department of Anatomy, School of Basic Medical Science, Southern Medical University, Guangzhou, China*

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Abstract

An unusual communication between the lingual and mylohyoid nerves has been identified as one reason for incomplete mandibular anaesthesia, and for neuropathy. However, its anatomical features and function are poorly understood and its relations with neighbouring structures, which are valuable in reducing the side effects of surgical operations, have not been sufficiently described. The aim of this study, therefore, was to describe the communication between the nerves and to assess the implications for oral and maxillofacial surgery. We explored the communication between the mylohyoid nerves of 62 embalmed, and 16 fresh, hemifaces. The diameter, length of the communication, and other variables were measured, and the junctions with the two nerves microdissected. The nervous communications of fresh specimens and relative nerves were stained histochemically for acetylcholinesterase. Of the 62 embalmed specimens, 19 had a communication that pierced the mylohyoid muscle, and staining showed that this was a sensory nerve. Our results suggest that the sensory communication between the lingual and mylohyoid nerves pierces the mylohyoid muscle and connects these otherwise unrelated nerves, thereby contributing to the likelihood of operative side effects.

Keywords: Lingual nerve; Mylohyoid nerve; Communicative nerve; Submandibular gland; Flap; Cadaver

Introduction

The region of the trigeminal nerve is a common area for surgical intervention, and anatomical variations in the branching pattern of the mandibular nerve can increase the difficulties of operation. It may also be a cause of neuropathy, and an explanation for the inefficiency of mandibular anaesthesia.[1–3] Among these variations, communication between the lingual and mylohyoid nerves is mentioned in a few published reports. Most of these are case reports[4,5] and, in most of the reported cases, the roots of the teeth and the mylohyoid muscle were not retained during dissection, so it remains difficult to confirm the relations between the nerves and the important structures that surround the nerves.[4–6] In addition, because all existing research is based on embalmed specimens, it is hard to clarify the properties of the nervous communication, which is crucial to identifying the effects of injuring this additional nerve.

* Corresponding authors at: No. 1023, Shatainan Road, Baiyun District, Guangzhou, Guangdong Province, China. Tel.: +86(20)61648198.
E-mail addresses: 410524583@qq.com (C. Zhan), 1029160434@qq.com (Z. Yuan), qurongmei@163.com (R. Qu), 1048695877@qq.com (L. Zou), shanlihesmu@sina.com (S. He), lizy2008@163.com (Z. Li), liuchang@fimmu.com (C. Liu), 13265038635@126.com (Z. Xiao), jouyang@126.com (J. Ouyang), daijx2013@163.com (J. Dai).
[1] Chaoning Zhan, Zhao Yuan, and Qu Rongmei contributed equally to this article.

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Importantly, the submandibular and submental triangles (in which communication between the lingual and mylohyoid nerves may occur) are involved in the removal of lower molar teeth, excision of the salivary gland, transplantation of flaps, and other common procedures. It is therefore crucial to be clear about relevant structures.

In response to the lack of a systematic study of the communication between lingual and mylohyoid nerves, and the importance of understanding the variations, we describe and summarise the variations in the communication between the lingual and mylohyoid nerves, and assess their implications for oral and maxillofacial surgery.

Material and methods

Sixty-two hemisectioned specimens of heads from adult Chinese embalmed cadavers (55 male and 7 female, aged 20–70 years) and 16 hemisectioned specimens of heads from fresh cadavers (all male aged 20–50 years) were used, after being used for teaching in the Department of Anatomy, Southern Medical University. All the specimens were from cadavers donated to the University. The study was approved by the Ethics Committee of the School of Basic Medical Sciences, Southern Medical University, and was done in accordance with the Helsinki Declaration. All the donors had previously given written consent for their body parts to be used for medical research or teaching.

The embalmed specimens were treated as follows. First, cotton moistened with 5% hydrochloric acid (Xilong Scientific Co Ltd) was placed on the surface of the mandible, and replaced at 24-hour intervals. After 5–7 days, part of the mandibular body and the ramus of the mandible were removed, whilst the roots of the tooth and the mylohyoid muscle were left in situ. The course of the mylohyoid nerve was exposed in the submandibular triangle, and the lingual nerve dissected until its point of entry into the submandibular region. Within the submandibular triangle we isolated the nervous communication between the lingual and mylohyoid nerves. In particular, attention was focused on the relation between this communication and the local nerves and bony structure. The diameters of the nerves and the length of this unusual communication were measured using Vernier calipers (resolution, 0.02 mm) and a ruler (resolution 1 mm). We also measured the angle between the mylohyoid nerve and the communication. The structures were photographed, and the angles measured using Photoshop CS6. Additionally, the rate of occurrence of the communications and their courses were recorded.

To confirm the relation between the lingual nerve, the mylohyoid nerve, and the communication between them in detail we used microtweezers and stereomicroscopic observation (Nanjing Yanan Special Light Factory, KD-202, ×6). We microdissected the points of the junction of the communication with the lingual nerve and the mylohyoid nerve by removing the epineurium from the specimens.

We isolated the nervous communication from the dissected heads to obtain the transverse sectional morphology, and cross-sections 5 μm thick from the intermediate section of the communication were then stained with haematoxylin and eosin.

The nervous communication, the mylohyoid nerve before its junction with the communication, the mylohyoid nerve beyond the junction, the lingual nerve before its junction with the communication, the lingual nerve beyond the junction, and the branch from the lingual nerve to the submandibular gland were removed from the cadavers using Karnovsky and Roots' histochemical method for acetylcholinesterase.[7] The concrete method was followed according to the manufacturer's instructions (Beijing Leagene Biotechnology Co Ltd, Serial Number: DE0056).

Results

We dissected 62 embalmed hemisectioned heads and in 19 of these we found a communication between the lingual and mylohyoid nerves that was located within the submandibular triangle. In most cases it arose from the top edge of the mylohyoid nerve and joined the lateral surface of the lingual nerve, having pierced the mylohyoid muscle. The junction with the lingual nerve was located at or beyond the point at which there was a branch from the lingual nerve to the submandibular gland. In most cases the junction with the mylohyoid nerve was inferior to the mandibular body, but in some cases it was below it (Fig. 1). In each case the course and branching pattern of the mylohyoid nerve were normal. The lingual nerve also displayed a normal course and branching pattern after insertion of the communicating branch from the mylohyoid nerve.

The mean (SD) diameter of the nervous communication was 1.47 (0.62) mm, while that of the mylohyoid nerve before its junction with the communication was 2.17 (0.77) mm; beyond the junction it was 1.56 (0.52) mm. The mean (SD) length of the communication was 20.9 (5.78) mm, and the angle between the communication and the mylohyoid nerve (measured beyond their junction) was 63.13 (25.37).

The variations noted in the communication were categorised morphologically. We divided the mandibular body into three equal sections from its superior to its inferior margin, so three types of communication were classified according to the point at which they pierced the mylohyoid muscle (Fig. 2):

Type I: the point at which the nervous communication pierced the mylohyoid muscle corresponded to the superior part of the mandibular body (Fig. 3, left).

Type II: the point at which the nervous communication pierced the mylohyoid muscle corresponded to the intermediate part of the mandibular body (Fig. 3, middle).

Type III: the point at which the nervous communication pierced the mylohyoid muscle corresponded to the inferior part of the mandibular body (Fig. 3, right).

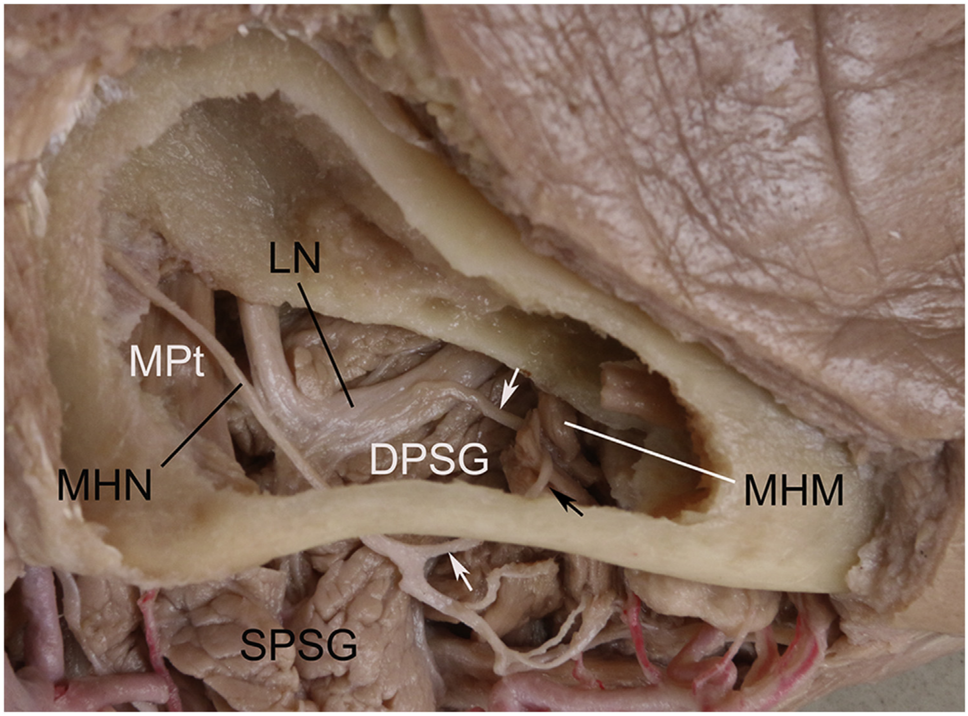

Fig. 1. The mylohyoid nerve gives rise to a nerve communication (arrows) at a point that is lower than the inferior border of the mandibular body. The communication is situated close to the deep portion of the submandibular gland. LN = lingual nerve, MPt = medial pterygoid, MHM = mylohyoid muscle, and SPSG/DPSG = superficial/deep portion of the submandibular gland.

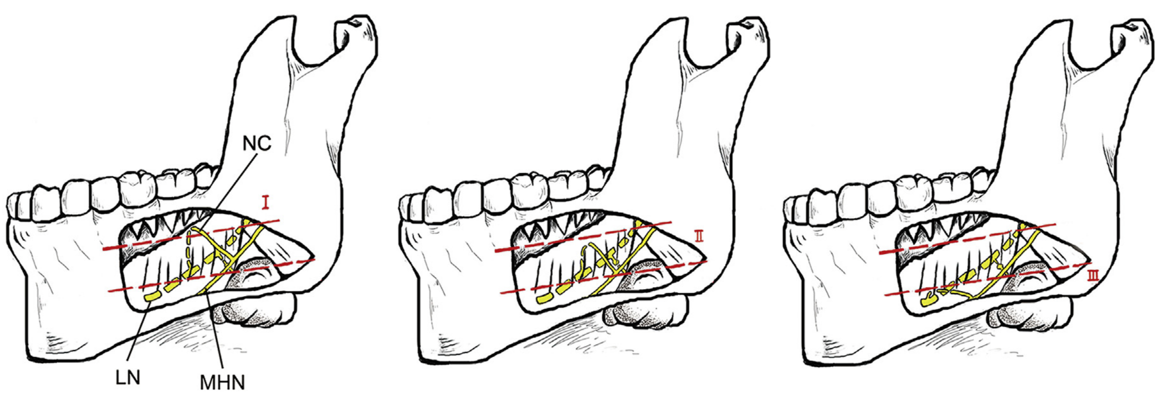

Fig. 2. Types of anatomical arrangement of the communicating nerve between the mylohyoid nerve (MHN) and the lingual nerve (LN), categorised according to the level of the point at which the communicating nerve pierces the mylohyoid muscle in the medial aspect of the mandibular body. Left = type I; Middle = type II;Right = type III. The dashed lines show the horizontal reference line that trisects the distance between the superior and inferior borders of the mandibular body.

There were only three cases each of Type I and Type III, most of the specimens that showed a communication (n = 13) were Type II. Remarkably, in one case, the point at which the communication pierced the mylohyoid muscle was next to the bone that corresponded to the root of the tooth. In one of the Type III cases, the point at which the mylohyoid muscle was pierced was just 6.30 mm higher than the inferior border of the mandible. Specific data for Types I–III are presented in Supplementary Table 1.

The communicating nerve arose from the mylohyoid nerve and ran into the lingual nerve. The fascicles of the nerve led directly into the tongue with the main trunk of the lingual nerve and, in three cases, one nerve connected with the submandibular ganglion (Fig. 4).

Light microscopy showed that the entire nerve was surrounded by epineurium, and that each individual nerve filament (axon) was covered with a myelin sheath. No abnormalities were detected (Supplemental Fig. S1).

We also found the nervous communication in four of the 16 fresh hemisectioned specimens (Supplemental Fig. S2). In the mylohyoid nerve, before its junction with the nerve communication, there was a bunch of myelinated nerve fibres that showed enzymatic activity in the axoplasm, but not in the sheath. In the rest of the nerve fibres, a lot of the axoplasm

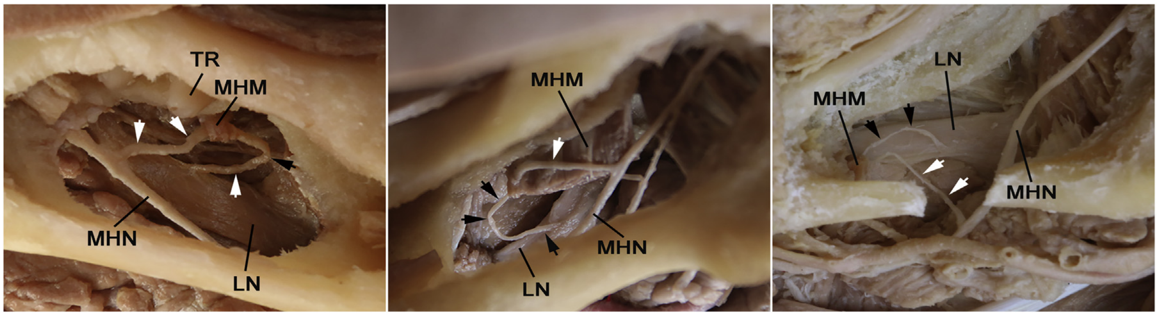

Fig. 3. The three types of nervous communication (arrows) according to the level of the point at which the communication pierces the mylohyoid muscle in the medial aspect of the mandibular body. Left panel = the point is located on the superior section of the mandible body. Middle panel = the point is located on the intermediate section of the mandible body. Right panel = the point is located on the inferior section of the mandible body. TR = tooth root, MHM = mylohyoid muscle, MHN = mylohyoid nerve, and LN = lingual nerve.

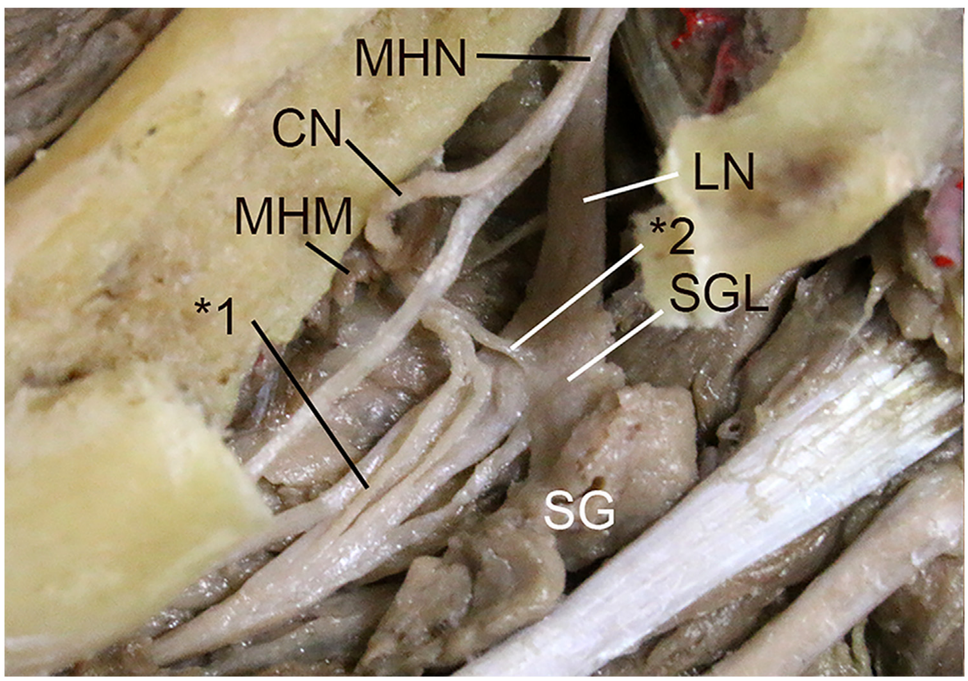

Fig. 4. Macroexamination and microexamination of the analysis of nerve fibres in the nervous communication. Fascicles of nerve fibres are running directly to the tongue (1), and the fascicle that connects with the submandibular ganglion (2). MHM = mylohyoid muscle, MHN = mylohyoid nerve, LN = lingual nerve, CN = nervous connection, SGL = submandibular ganglion, and SG = submandibular gland.

failed to react, but there were numerous irregular masses among the myelinated fibres. The staining appeared in the mylohyoid nerve before and after the junction of the nervous communication (Supplemental Fig. S3). The lingual nerve both before and after its junction with the nervous communication contained several bunches of previous staining.

Discussion

Nervous communications between the lingual and mylohyoid nerves have been mentioned in previous publications, and the incidence found by different research workers has varied from 1.45% to 12.50%.[1,6,8] However, we found a high incidence of the supposedly unusual communication between the two nerves (19 of 62 specimens), which was remarkably higher than that reported in previous studies, possibly as a result of racial variations. In any event the variation occurs with considerable frequency and clinicians should not ignore it.

Kim et al[1] described the existence of the communication, and speculated that it provides another route for collateral sensory transmission, which may result in incomplete anaesthesia during dental practice. However, we could find no reports of this communication. Based on histochemical analysis for acetylcholinesterase, our purpose was to confirm or deny that such a communication may be a sensory nerve, as previously mentioned by other research workers. Although the effect of enzyme-histochemical staining is not perfect because the enzyme degrades easily, the distinction between motor and sensory nerve fibres is still easy to make. It indicates that some sensory fibres of the mylohyoid nerve may innervate the tongue, and surgeons might wish to be aware of this in their interpretation of the aberrant results after oral and maxillofacial surgical operations. At the same time, this offers a possible explanation for the fact that the lingual nerve usually repairs itself within six months of damage.[9]

Our results have shown that the communication between the lingual nerve and the mylohyoid nerve lies lateral to the deep portion of the submandibular gland (Fig. 1) so, during each procedure, the region in which the nervous communication occurs must be probed and studied carefully. Keeping a keen eye open for the supposedly unusual communication between the lingual nerve and the mylohyoid nerve needs to be part of the strategy to prevent side effects of surgical operations. Based on the observations of the microanatomy of the junctions with the lingual nerve and the mylohyoid nerve seen histochemically with acetylcholinesterase, we think there is a risk of permanent or temporary paraesthesia of the tongue when surgeons injure the communicating nerve. This differs from damage to the mylohyoid nerve caused by excision of the submandibular salivary gland, which may cause numbness over the chin.[10]

Another interesting finding of the study was the course of the communication. All the communicating nerves that we exposed pierced the mylohyoid muscles, and may be a possible causes of neuropathy.[3] More importantly, the nervous communication between the lingual and mylohyoid nerves would affect the performance of the mylohyoid flap. This flap plays a crucial part in the treatment of bisphosphonate-associated osteonecrosis,[11,12] the closure of composite defects in the oral cavity,[13] and even facial reanimation.[14] However, most of the reported studies of these procedures did not suggest that the surgical protocol should be altered in the event of a communication between the mylohyoid nerve and the lingual nerve. For example, in facial reanimation, an innervated mylohyoid/digastric flap procedure has been done that is based on anatomical information and has been used successfully in clinical operations. In this flap, the sole nerve that is present is the mylohyoid nerve. It is necessary to keep this nerve intact, instead of allowing a free flap, to prevent atrophy and progressive fibrosis.

However, in the event of nervous communication between the lingual and mylohyoid nerves, a mylohyoid/digastric flap cannot be successfully constructed because the nerve communication pierces the mylohyoid muscle and therefore the mylohyoid muscle and nerve, as well as the lingual nerve, together form an associated structure. To transpose the mylohyoid/digastric flap to an appropriate position, the solution is to sever the communication, but this operation may affect the lingual nerve. Because of the high incidence of the communication between the lingual and mylohyoid nerves reported here, surgeons should examine whether such a communication exists before releasing muscles from their attachments on the mandible.

Although to our knowledge there are as yet no reported studies that have described this nervous communication during operation, the results of our study provide evidence that side effects may arise through damage to this communication between the lingual nerve and the mylohyoid nerve.

In summary, surgeons should prejudge, and search for this communication before embarking on operations in the sublingual and submental areas. Because we observed the incidence of this communication only in specimens, and did not verify it at operation, we need to verify it clinically in future studies.

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Ethics statement/confirmation of patients' permission

The study was approved by the Ethics Committee of the School of Basic Medical Sciences, Southern Medical University. All the donors had given written consent previously for their body parts to be used for medical research or teaching.

Conflict of interests

We have no conflicts of interest.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.bjoms.2019.03.003.

References

1. Kim SY, Hu KS, Chung IH, et al. *Surg Radiol Anat* 2004;**26**:128–35.
2. Anil A, Peker T, Turgut HB, et al. Variations in the anatomy of the inferior alveolar nerve. *Br J Oral Maxillofac Surg* 2003;**41**:236–9.
3. Shimokawa T, Akita K, Sato T, et al. Penetration of muscles by branches of the mandibular nerve: a possible cause of neuropathy. *Clin Anat* 2004;**17**:2–5.
4. Potu BK, D'Silva SS, Thejodhar P, et al. An unusual communication between the mylohyoid and lingual nerves in man: its significance in lingual nerve injury. *Indian J Dent Res* 2010;**21**:141–2.
5. Sinha P, Tamang BK, Sarda RK. Communication between mylohyoid and lingual nerve: an anatomical variation. *J Clin Diagn Res* 2014;**8**. AD01-2.
6. Thotakura B, Rajendran SS, Gnanasundaram V, et al. Variations in the posterior division branches of the mandibular nerve in human cadavers. *Singapore Med J* 2013;**54**:149–51.
7. Karnovsky MJ, Roots L. A "direct-coloring" thiocholine method for cholinesterases. *J Histochem Cytochem* 1964;**12**:219–21.

8. Sato I, Sunohara M, Ueno R, et al. Branch of mylohyoid and lingual nerves on submandibular and submental triangles. *Okajimas Folia Anat Jpn* 2004;**81**:45–8.
9. Chossegros C, Guyot L, Cheynet F, et al. Is lingual nerve protection necessary for lower third molar germectomy? A prospective study of 300 procedures. *Int J Oral Maxillofac Surg* 2002;**31**:620–4.
10. Adjei SS, Hammersley N. Mylohyoid nerve damage due to excision of the submandibular salivary gland. *Br J Oral Maxillofac Surg* 1989;**27**:209–11.
11. Lemound J, Eckardt A, Kokemüller H, et al. Bisphosphonate-associated osteonecrosis of the mandible: reliable soft tissue reconstruction using a local myofascial flap. *Clin Oral Investig* 2012;**16**:1143–52.
12. Mücke T, Koerdt S, Jung M, et al. The role of mylohyoid flap in the treatment of bisphosphonate-related osteonecrosis of the jaws. *J Craniomaxillofac Surg* 2016;**44**:369–73.
13. Sawhney R, Young L, Ducic Y. Mylohyoid advancement flap for closure of composite oral cavity defects. *Laryngoscope* 2011;**121**:2313–6.
14. Aszmann OC, Ebmer JM, Dellon AL. The anatomic basis for the innervated mylohyoid/digastric flap in facial reanimation. *Plast Reconstr Surg* 1998;**102**:369–72.