Arch. Psychiat. Nervenkr. 227, 271–277 (1979)

Archiv für Psychiatrie und Nervenkrankheiten
Archives of Psychiatry and Neurological Sciences

The Gastroauricular Phenomenon and Related Vagus Reflexes

D. Engel

Zürich, Switzerland

Summary. Eight lesser known reflexes were grouped together because of their anatomical and physiological relationship. In all of them a branch of the vagus nerve forms a bridge between a circumscribed area of the skin, mostly the external auditory meatus, and an internal organ, namely the stomach, esophagus, lungs, heart, uterus, and some male and female sex organs.

The eight reflexes are:

(1) Gastroauricular phenomenon (Gaph) (Engel, 1922) in man;
(2) Auricular phenomenon (Malherbe, 1958) in man;
(3) Pulmonoauricular phenomenon (Deutsch, 1919) in man;
(4) Auriculogenital reflex (Bradford, 1937) in cat;
(5) Auriculouterine reflex (Vasiliu, 1932) in women;
(6) Oculocardiac reflex (Aschner, 1967) in man;
(7) Kalchschmidt's reflex in cattle (1956); and
(8) Coughing attack with heartburn (Berlin, 1959) in man.

The organs involved are either effector or receptor organs. The six reflexes observed in man are of diagnostic significance. Attention is also drawn to analogous reflexes in which the meningeal branch of the vagus is involved.

Key words: Vagus nerve reflexes – Gastroauricular phenomenon – Auricular vagal branch.

Zusammenfassung. Acht weniger bekannte Reflexe werden wegen ihrer anatomischen und physiologischen Zusammengehörigkeit in einer Gruppe angeführt. In diesen bindet ein Vagusast, meistens der Ramus auricularis vagi, eine Brücke zwischen einer umschriebenen Hautstelle, meistens dem äußeren Gehörgang, und einem inneren Organ (Magen, Oesophagus, Lunge, Herz, Uterus) oder männlichen oder weiblichen Geschlechtsteilen.

Send offprint requests to: Dr. D. Engel, M.D., F.R.C.S., Voltastrasse 64, CH-8044 Zürich, Switzerland

Die acht Reflexe sind:

1) Gastro-auricular-Phänomen (Gaph) (Engel, 1922) beim Menschen;
2) Auricular-Phänomen (Malherbe, 1958) beim Menschen;
3) Pulmono-auricular-Phänomen (Deutsch, 1919) beim Menschen;
4) Auriculo-genital-Reflex (Bradford, 1937) bei der Katze;
5) Auriculo-uterine-Reflex (Vasiliu, 1932) bei der Frau;
6) Oculo-cardialer Reflex (Aschner, 1967) beim Menschen;
7) Kalchschmidts Reflex (1956) beim Rind und
8) Hustenanfall mit Sodbrennen (Berlin, 1959) beim Menschen.

Die inneren Organe sind entweder Effektor- oder Rezeptor-Organe. Die menschlichen Reflexe (1, 2, 3, 5, 6, 8) können auch von diagnostischem Interesse sein.

Es wird auch auf analoge Reflexe eines anderen Vaguszweiges, dem Ramus meningeus, hingewiesen.

Schlüsselwörter: Vagus-Reflex – Gastro-auricular-Phänomen – Ramus auricularis vagi.

In 1922 a new syndrome was described under the name Gastroauricular Phenomenon (Gaph) (Engel, 1922). This longforgotten phenomenon has lately acquired some practical significance; furthermore, additional phenomena and reflexes have been described which are closely related to Gaph anatomically and physiologically. The common characteristic of these phenomena is that the ramus auricularis of the vagus nerve reacts to stimulation of an internal organ, the stomach, lungs, or uterus or conversely that the stimulation of the ramus auricularis elicits a reflex reaction of the vagina or penis.

1. The description of Gaph was based on a self-observation: Whenever I suffered from heartburn, I felt simultaneously an intense itching in the left external auditory meatus and the drum. When the sensation is mild, it feels like tickling; when it is more intense, it feels like a disagreeable itching that compels one to scratch the auditory meatus with a toothpick or a hairpin. Bicarbonate of soda taken orally relieves the itching immediately. One may have occasional heartburn without itching, but hardly ever itching without heartburn.

The phenomenon is very common. In one surgical ward of 15 beds I once found 3 patients suffering from it and, after a lecture given on this subject to about 50 to 60 doctors, two told me during the discussion that they had observed the Gaph in themselves. None of the people suffering from Gaph whom I examined suffered from any gastrointestinal trouble; nor could I ever find any dermatological local changes to explain the itching.

The neurological status of all examined cases was normal, and no other reason for the itching apart from the pyrosis, was found.

The ramus auricularis of the vagus is the only peripheral branch of this nerve. Its cells of origin are in the medulla oblongata, above the olive. Some of the cells form the dorsal nucleus visceralis; others form the medial nucleus ambiguus (motor). The fasciculus solitarius (sensory) is connected with the ganglion

jugulare and ganglion nodosum. The auricular branch of the vagus emerges between these two ganglia. The trophic center of the auricular branch is in the ganglion nodosum.

In its lower course the left branch of the left vagus supplies the fornix and the upper two thirds of the body of the stomach; its middle branch innervates the prepyloric part; and its right branch, the liver. The left branch of the right vagus innervates the cardia, the small curvature, and a part of the body; its right branch spreads into the semilunar ganglion; and its middle branch innervates the posterior part of the prepyloric section. The two vagi are usually separate and seldom anastomose. These anatomical conditions explain why in most Gaph cases the itching is mostly unilateral and usually on the left side.

Following is a proposal for the route of the gastric stimulus to the ear: The sensory endings of the left vagus are stimulated by the hyperacidity of the stomach, and the stimulus is passed to the ganglion nodosum which also includes the ganglion cells of the auricular branch. By some further synapses of the afferent neurons from the stomach, they may converge with those that came from the auditory meatus, and the stimulus may pass through the fasciculus solitarius to the cortex.

Professor Kümmel, former Head of the Otological University Clinic in Heidelberg, suggested in a personal communication that the cortical sensory center of the auricular branch of the vagus nerve is well circumscribed. One of Kümmel's patients, in his epileptic aura, always felt a bilateral itching of the external auditory meatus, similar to that of Gaph.

The Gaph was unknown at the time of publication and fifty years later it remains so. However, the otological textbooks mention a pruritus nervosus of the external meatus, in which the skin is normal and the cause unknown. It is possible that some of these cases suffer from Gaph.

In order to provoke the symptoms of Gaph, 100 ml of a 1% HCl solution was given per os to two patients and simultaneously 0.1 and 0.2 mg of pilocarpin was s.c. injected. Neither of the two patients reacted with Gaph; nor did they complain of heartburn. The unsuccessful attempt to provoke the symptoms of Gaph with pilocarpin does not necessarily argue against the vagus being involved in the conduction of the itching sensation. The coincidence of several conditions might be necessary to evoke Gaph. This may explain the disappearance of Gaph in my self-observation: For the last thirty years I have not experienced the symptoms of Gaph, although I still suffer from heartburn as before. Repeated X-ray examinations of the gastrointestinal tract showed no gastric or duodenal ulcer. The reason why Gaph has remained unrecognized may be that a connection between the stomach and the external auditory meatus is regarded as improbable.

2. A phenomenon closely related to Gaph was described by Malherbe (1958). He observed three cases of esophageal hiatus hernia associated with painful itching in the external meatus of the ear.

Malherbe explained the itching as a referred pain along the vagus, irritation of the esophageal filaments being misinterpreted centrally as coming from the auricular branch. In two of Malherbe's cases the diaphragmatic hernia was repaired and the itching disappeared; in the

third case, however, the itching disappeared without an operation when the patient went on a reducing diet with frequent meals.

Malherbe thought that the stimuli producing the itching in the ears consisted of stretching pressure by inflammatory involvement of the vagus—and he may be right. On the other hand, the fact that in one of his three cases the itching disappeared without a hernia operation, simply by dieting and small meals, suggests that the ear itching in Malherbe's cases was caused by regurgitation of acid gastric juice into the prolapsed cardia or esophagus. It would have been interesting to know whether the itching would have disappeared after administration of antacids. In that case Malherbe's syndrome should be considered identical with Gaph. Should the itching not respond to antacids, then Malherbe's syndrome should be classified as closely related to Gaph.

3. Another 'auricular phenomenon' similar in principle to Gaph is that of Deutsch (1919). In this phenomenon it is not the stomach, but the *lung* that is involved. In cases of lung tuberculosis the skin area of the auricular branch of the vagus proved to be hypersensitive, especially on the side of the more advanced tubercular process. Deutsch explained his phenomenon on the basis of Head's (1894) zones. In view of the existence of the gastroauricular phenomenon, it might be advisable to call Deutsch's syndrome pulmonoauricular phenomenon.

The above three reflectory phenomena were observed in men and could not therefore be studied anatomically. These restrictions did not apply to Bradford's observations of the *auriculogenital reflex* (Agr) in cats.

4. Bradford (1937) made a thorough anatomical and physiological study of the Agr in cats, which also shed some light on the phenomena described above. Hence, they will be reported in greater detail. The reflex was observed in male and female cats, but not in any other domestic animal.

The stimulus is applied manually by grasping the external ear posterolaterally at its base and rubbing it rapidly between the index finger and thumb. Introducing a finger or cotton swab into the external auditory canal and rotating it rapidly in alternate directions, while maintaining pressure, will also act as an adequate stimulus. Observing the vaginal orifice during the stimulation, a gross contraction of the musculature around the orifice will be noticed. The contractions are different from the spontaneous perianal and perivaginal contractions. The contractions begin promptly with the stimulus and subside promptly after its cessation.

In the male cat the stimulation is the same as in the female, but the muscular reflex consists of contractions of the cutaneous muscles about the penis and perineum. The reflex can be elicited in about 90% of male and female cats. The scratch reflex is elicited in the same manner as the auriculogenital reflex. As a rule, both are elicited together, but the auriculogenital can be elicited only by stimulating the aural region. In dogs, rabbits, and monkeys no Agr could be elicited. The reflex does not depend on the estral cycle.

In decerebrated cats the reflex can easily be elicited by faradic stimulation. To determine the afferent end of the reflex arc, the cervical nerves, the trigeminal, acoustic, and facial nerves were divided without interfering with the reflex. But when the group of nerves passing through the foramen jugulare (9th, 10th, 11th) was divided, the reflex was interrupted. The separation of the three nerves was difficult, but since only the tenth nerve has an aural branch, it was reasonable to assume that the reflex passes through this branch.

The efferent pathway leads over the eighth cervical and first thoracic anterior roots, the brachial plexus and over a long nerve coursing down the lateral abdomen and then medially to the genitalia. The efferent pathway crosses above the second cervical segment, probably in the brain stem.

In the cat the licking of the head and ears preliminary to coitus elicits the Agr. The movements thus elicited at the site of the genital organs produce afferent impulses which might cause sexual stimulation. Cats frequently rub their heads against a chair. The ear is usually

folded and receives stimulation which, as well as the rolling of the female cat in heat, may also elicit the Agr. The effects of the Agr in the male cat were not described in detail, but would probably serve the same purpose.

5. An interesting and apparently little known syndrome is the *auriculouterine reflex* described by D. I. Vasiliu (1932), based on a single observation.

A woman of 32 felt very violent pain in her left ear and also in her lumbar region. A few hours later she noticed bleeding from the same ear and 15 min later her menstruation started. When she saw her doctor the same morning, he found a bleeding erosion from the left drum, extending to the inferior part of the auditory canal. The doctor wiped off the blood, but the bleeding did not stop. He described his observation: "I repeated touching the bleeding ear five or six times at shorter or longer intervals and *each time, after touching the patient's ear, she repeated saying that she had the sensation of menstrual bleeding (flux).* The doctor concluded that in this case a reflectory uterine contraction took place, elicited from the erosion of the ear. He considered the bleeding to be a vicarious menstruation.

The patient said that she had had the same kind of bleeding two or three times several months earlier; no interval was mentioned. Vasiliu did not find a similar case in the literature and thought it was caused by a "reflex of sympathetic nature." It is likely that this reflex is analogous to Bradford's Agr.

6. In the *oculocardiac reflex* (Aschner, 1967), the eyeball is the receptor and the heart, the effector organ. By pressure the heart rate and possibly also the respiratory rate is slowed down (pulse rate lowered by 5 to 8 beats per min). The afferent portion of the reflex arc is carried through the trigeminal nerve, and the efferent portion through the vagus nerve. The reflex is a manifestation of vagal hypersensitivity; it is absent in vagus paralysis and increased in vagotonic individuals. The reflex can also be elicited by painful stimulation of the skin on the side of the neck. This reflex is decreased in sympathicotonics.

7. The Kalchschmidt Sign in Cattle. A diagnostic method well known to veterinary surgeons was described by Kalchschmidt (1956). He discovered in cattle in cases of perforation of the rumen and even pressure by a foreign body on the rumen, a hyperalgesic Head zone in the withers and the lateral thoracic area. If this hyperalgesic skin of the withers is lifted up from the neck, the animal responds with a characteristic groaning sound and arrested breathing. It is probable that the vagus nerve is involved in eliciting this reflex.

8. Coughing Attack with Heartburn. A short Letter in the Lancet by Ragnar Berlin (1959) in response to my article, may also be mentioned. He observed in ten Swedish patients, including himself, a synchronous heartburn and an "imperative coughing attack following an intense feeling of pricking in the upper part of the trachea and in the larynx." Bicarbonate of soda taken orally alleviated the cough at once. Direct stimulation of the respiratory area was excluded. Berlin accepted my explanation of intraneural shortcircuit for his syndrome of, perhaps, sui generis.

Comment and Discussion

The eight reflex phenomena described here, the gastroauricular phenomenon (Engel, 1922), the auricular phenomenon (Malherbe, 1958), the pulmonoauricular

phenomenon (Deutsch, 1919), the auriculogenital reflex (Bradford, 1937), the auriculouterine reflex (Vasiliu, 1932), the oculocardiac reflex (Aschner, 1967), the Kalchschmidt's reflex in cattle (1956), and the coughing attack with heartburn (Berlin, 1959), all have one common denominator: One branch of the vagus nerve, chiefly the auricular, acts as a bridge between a circumscribed area of the skin, mostly the external auditory meatus, and an internal organ. These organs from which or to which the reflex is elicited are very widespread: The stomach, the esophagus, the lungs, the heart, the uterus, and the perivaginal and periscrotal musculature.

The question of why an anatomically insignificant branch of the vagus should have such widespread functional manifestations can only be answered speculatively: First, the auricular branch is the only peripheral branch of the vagus nerve. Second, this branch is the last phylogenic remnant of the nerve which innervates the lateral line organs in fish and amphibia. The ganglia of the vagus receive cells, not only from the neural crest, but also from the placodes, which are, in the region of the head, proliferations of the deeper layers of the epidermis.

There are two kinds of placodes: an upper row of dorsolateral placodes which give rise to the lateral line sense organs and to the nerve cells whose fibers innervate them. A lower row of epibranchial placodes originates at the dorsal end of the branchial clefts and, in the lower vertebrates, their cellular proliferation contributes to the neighboring ganglia. In man, the relations of all the placodes are not so clear, although contributions from the epibranchial placodes to the ganglia of the vagus and other nerves have been observed (de Beer, 1936; Arey, 1961).

Deutsch explained his auricular phenomenon by taking the auricular skin area to be the reflected Head zone elicited from the lungs. Head himself seems to contradict this view. He says explicitly: "There are certain parts which do not cause referred pain because they belong to the surface lining of the body. Such parts are the conjunctiva, the epithelium on the anterior layer of the cornea, and the external auditory meatus."

The other sensory branch of the vagus nerve, apart from the auricular, is the *meningeal branch* which innervates the occipital and part of the parietal dura. In view of the described reflex phenomena of the auricular branch, it seems likely that the meningeal branch, which innervates a much larger and more sensitive area, may also be involved in similar reflectory phenomena. Many patients with gastric and intestinal troubles suffer from headache (Faber, 1900). It is possible that these are caused by a stimulation of the vagus (gastric branch), and the stimulus, instead of being transmitted by the auricular ramus, is transmitted by the meningeal one.

Numerous patients suffering for years from severe headache and resisting any treatment lose their headache immediately after having their occipital nerves blocked by 10 ml-s of a 0.5% novocain solution. It is likely that the occipital nerve has some indirect connection with the meningeal branch.

The vomiting caused by meningitis or by increased intracranial pressure has also to be considered as a reflex transmitted by the meningeal vagus branch, between the meninges (receptor) and stomach (effector organ).

Some of the reflexes described are, apart from anatomic and physiologic, also of diagnostic interest, especially to the otologist and neurologist.

The classification of the above eight reflexes under one heading lays no claim to exclusiveness. On the contrary, it may encourage further observation, possibly pertaining to other than the auricular branch of the vagus. It is possible, for instance, that the meningeal branch is involved in the dermocerebral reflex (Engel, 1954), the mechanism of which is, so far, unknown.

References

Arey, L. B.: Developmental anatomy. Philadelphia: W. B. Saunders 1961

Aschner: In: The neurological examination, De Jong, R. N. (ed.), p. 315. New York, London: Höber Med. Division 1967

Beer, G. R. de: Vertebrate zoology. London: Sidgwick and Jackson 1936

Berlin, R.: The gastro-auricular phenomenon. Lancet **1959 I**, 734—735

Bradford, F. K.: The auriculo-genital reflex in cats. J. Exp. Physiol. **27**, 272—279 (1937)

Deutsch, M.: Ein Beitrag zur Symptomatologie der beginnenden Lungentuberkulose. Med. Klin. **43**, 1090—1091 (1919)

Engel, D.: Über das reflektorische Ohrenjucken bei Sodbrennen. Med. Klin. **47**, 1495—1497 (1922)

Engel, D.: Reaction of the cerebral circulation to thermal stimulation of the limbs. Acta Psychiat. Scand. **29**, 61—70 (1954)

Engel, D.: The gastro-auricular phenomenon. Lancet **1959 I**, 371—372

Faber, K.: Reflexhyperästhesien bei Verdauungskrankheiten. Dtsch. Arch. Klin. Med. **65**, 332—384 (1900)

Head, H.: On disturbances of sensation with special reference to pain of visceral disease. Brain **17**, 339—480 (1894)

Kalchschmidt: In: Lehrbuch der klinischen Diagnostik, J. Mared, J. Mocsi (eds.), S. 293—294. Jena: G. Fischer 1956

Malherbe, W. D. F.: Otalgia with oesophageal hiatus hernia. Lancet **1958 I**, 1368—1369

Vasiliu, D. I.: Reflex auriculo-uterin. Spitalul. **52**, 396 (1932)

Received April 25, 1979